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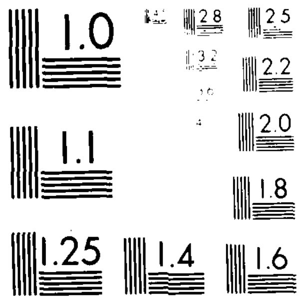
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AD-A156 221

MERRIMACK RIVER BASIN
SALEM, NEW HAMPSHIRE

MILLVILLE RESERVOIR DAM

N H 00030

NHWRB 209.08

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

APRIL 1979

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
Salem, New Hampshire
Hittytity Brook, Tributary to Spicket River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is an earth and concrete dam with an overall length of 484 ft. and a height of 20 ft. The drainage consists of 10.1 square miles of rolling terrain. It is small in size with a significant hazardpotential. It is in poor condition at the present time. Several further investigations and remedial measures need to be implemented at the site.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

JUN 08 1979

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

I am forwarding to you a copy of the Millville Reservoir Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Spicket River Corporation, 550 Broadway, Lawrence, Massachusetts 01840.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely yours,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

MILLVILLE RESERVOIR DAM

MERRIMACK RIVER BASIN
SALEM, NEW HAMPSHIRE

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I REPORT

Identification No.:	NH [illegible]
NHWRB No.:	[illegible]
Name of Dam:	MILLVILLE RESERVOIR DAM
Town:	Salem
County and State:	Rockingham County, New Hampshire
Stream:	Hittytity Brook, Tributary to Spicket River
Date of Inspection:	November 1, 1978

BRIEF ASSESSMENT

Millville Reservoir Dam is an earth and concrete dam with an overall length of 4[illegible] feet and a height of 2[illegible] feet. The [illegible] structure is about 125 feet long and concrete [illegible] are [illegible] in each earth embankment section. The outlet structure is a [illegible] foot waste pipe which has not been operated for at least two years. An abandoned intake structure is not operable and has been filled with earth.

The dam, which lies on the Hittytity Brook in Salem, N.H., was originally built to supply water for downstream mills. [illegible] the dam does not provide water to downstream mills [illegible] the aesthetics of the area with many homes built around the edge of the reservoir. The drainage area consists of 10.1 square miles of rolling terrain. There are numerous reservoirs and swamps upstream of the dam. The dam's maximum impoundment of 690 acre-feet and height of 18 feet [illegible] the dam in the SMALL size category. The possibility of significant property damage but remote chance for loss of life under the assumed failure conditions results in a SIGNIFICANT hazard potential classification.

Based on the size and hazard classifications, and in accordance with the Corps of Engineers guidelines, the Test Flood (TF) should be between the 100-year flood and one-half the Probable Maximum Flood (PMF). Since the hazard potential is on the [illegible] side of the SIGNIFICANT category, the Test Flood for Millville Reservoir Dam is taken as one-half of the PMF.

The selected TF inflow to the reservoir is 5050 cfs. Because of the effects of storage the outflow at the dam would be 4[illegible] cfs with a peak water level 5.6 feet above the minimum spillway elevation or 2.2 feet above the right embankment and 1.4 feet above the left embankment.

The spillway capacity is 1050 cfs prior to overtopping the right embankment. This is 22 percent of the TF flow.

Millville Reservoir Dam is in POOR condition at the present time. Several further investigations and remedial measures need to be implemented at the site. It is recommended that the services of a registered professional engineer be retained to investigate the seepage through the spillway and the [illegible] training walls, to determine the location and proper method of sealing the outlet from the abandoned overflow structure, to determine the structural adequacy of the waste gate structure, to investigate seepage downstream left of the spillway, and to perform further hydrologic and hydraulic studies to increase the [illegible] capacity of the dam. The results and recommendations [illegible] of these future studies should be implemented [illegible] [illegible] studies.

[illegible] remedial measures should be undertaken by the [illegible]. All deteriorated concrete on the spillway, waste gate structure and training walls should be repaired [illegible] [illegible] inspections should be instituted [illegible] [illegible] should be cleared from the downstream embankment [illegible] debris should be cleared from the downstream [illegible] warning system to alert downstream [illegible] in the event of an emergency should be instituted.

[illegible] improvements outlined above should [illegible] [illegible] receipt of this report by the [illegible]

THE STATE OF NEW HAMPSHIRE
WILLIAM
S.
Z[illegible]
No. [illegible]
REGISTERED
PROFESSIONAL ENGINEER

REGISTERED PROFESSIONAL ENGINEER
NICHOLAS ANTHONY CAMPAGNA, JR.
No. 21,006
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STATE OF CALIFORNIA

[illegible signature]

Nicholas A. Campagna

William S. [illegible]
N.H. Registration [illegible]

Nicholas A. Campagna, Jr.
California Registration 210[illegible]

[illegible] report [illegible] Millville Reservoir Dam [illegible] reviewed by the undersigned Review Board [illegible] the reported findings, conclusions, and [illegible] with the Recommended Guidelines for Safety [illegible] and with good engineering judgment and practice, and [illegible] for approval.

Joseph A. McElroy

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
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Joseph W. Finegan, Jr.

JOSEPH W. FINEGAN, JR., CHAIRMAN
Chief, Reservoir Control Center
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the Test Flood should not be interpreted as necessarily posing a highly inadequate condition. The Test Flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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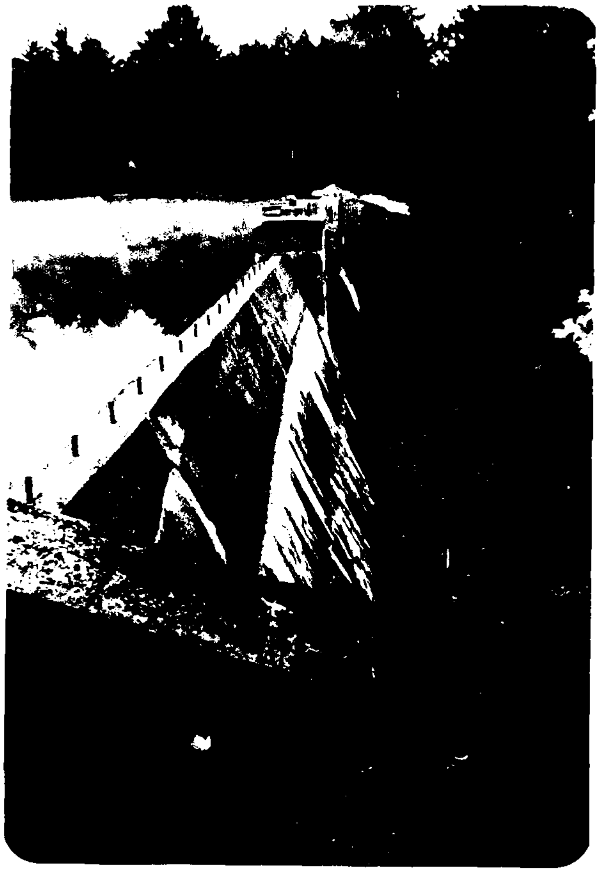

Overview from right endwall


Overview from left endwall

The [illegible] portion of the structure [illegible] running approximately normal to the spillway [illegible] severely spalled. The spalling is [illegible] severe in [illegible] feet of the [illegible]. The wall [illegible] [illegible] 75 [illegible] its surface. Seepage [illegible] [illegible] 2 gpm, is flowing through a [illegible] [illegible] this [illegible] [illegible] attributed to the [illegible] [illegible] been subjected to alternating freeze [illegible]

[illegible] between the skewed [illegible] [illegible] training wall and the [illegible] [illegible] the spillway [illegible] [illegible] are attributed [illegible]

[illegible]

[illegible] There were [illegible]

The embankment itself is [illegible] [illegible] small trees [illegible] [illegible] seepage was [illegible] [illegible] the embankment [illegible] 75 feet [illegible] [illegible] there was a wet area [illegible] [illegible] in diameter. Approximately [illegible] was [illegible] of this area. It was [illegible] to determine whether this seepage [illegible] the dam or from the surrounding downstream area. Seepage further downstream was [illegible] [illegible] the downstream slope. The [illegible] was [illegible]

[illegible] Intake Structure

[illegible] the structure [illegible] were observed [illegible] [illegible] are the remnants of [illegible] [illegible] This structure has been filled with earth and abandoned. On the downstream side of the left [illegible] end structure and beyond the downstream [illegible] of the embankment in line with this structure, the [illegible] noted in Sections (5) and (7) above [illegible]

[illegible] are present on the downstream face of the [illegible] cap. Many of these cracks are [illegible]. Where [illegible] resistance is very noticeable on the downstream spillway surface, [illegible] prevalent.

[illegible]

The waste gate outlet structure [illegible] is in very poor condition. The downstream vertical face is spalled over 75% of its surface area to depths of [illegible] to 5 inches. The exposed [illegible] [illegible]. This spalling is [illegible] moisture intrusion which has been subjected to [illegible] freeze and thaw cycles. [illegible] the spalling is [illegible] feet, a width of [illegible] and depth [illegible] inches. This [illegible] is attributed to [illegible] concrete, ice damage, and moisture intrusion [illegible] been subjected to [illegible] freeze and thaw cycles. The wall [illegible] random cracking [illegible] its entire [illegible]. The [illegible] downstream corner of the structure is [illegible] point above the [illegible]. The spalling is up to 12 inches [illegible] moisture intrusion [illegible] alternating freeze and thaw [illegible] structure [illegible] the normal tailwater [illegible]. Seepage was observed flowing [illegible] around the gate at a rate of [illegible]. The upstream training walls leading to the structure were submerged but did not show signs of deterioration. The timber [illegible] which is operable, is mounted on a timber frame. According to the owner's representative the gate has not been operated in at least 2 years.

[illegible] spillway [illegible]

The [illegible] extends [illegible] approximately 15 feet into the left embankment has minor hairline cracking on its top surface and minor erosion on its upstream face. The erosion is attributed to ice damage. The back face has minor random cracking with associated efflorescence (Photo 9).

Spillway

The right section of the structure (Photo 2) is [illegible] cracked, and effloresced on the downstream face. The left end of this spillway section has two eroded pockets. The first of these pockets is located [illegible] the dividing pier [illegible]. This pocket is 4 feet long, 2 feet high, and up to 12 inches deep. Vegetation is growing in this pocket. There is evidence of past seepage out of this pocket, but none was observed at the time of the inspection. The second pocket [illegible] the right [illegible] the dividing pier [illegible] the downstream [illegible]. This pocket [illegible] 2 feet high, and up to 12 inches [illegible] 7 feet long, 2 feet high [illegible] inches deep. [illegible] continues from this [illegible] the pocket [illegible] a [illegible] longitudinal opening at a rate [illegible]. The erosion is attributed [illegible] alternating freeze [illegible]. A continuous horizontal construction joint [illegible] the downstream face [illegible] spillway. This joint is effloresced. There are several vertical hairline cracks which are [illegible] effloresced. The pier dividing the right [illegible] is eroded [illegible] spillway. The [illegible] vertical [illegible] attributed [illegible].

The center section of this structure [illegible] has [illegible] open horizontal construction joints and [illegible] vertical construction joint. Seepage at the rate of 1/2 to 1 gpm is flowing out of the vertical joint. The intermediate pier is eroded at its interface with the spillway crest, and its upstream vertical face is eroded. This erosion is attributed to [illegible] damage.

The downstream face of the left spillway section [illegible] 7) is in very [illegible] downstream [illegible] the concrete cap which was placed over the original spillway section is undermined over almost [illegible] length at the interface with the old spillway. Seepage of about 1 to 2 gpm was observed at this interface. Random vertical and horizontal

SECTION 3 - VISUAL OBSERVATIONS

3.1 Dam [illegible]

a. General

[illegible]

b. [illegible]

1. Right Embankment and [illegible] Wall [illegible]

The embankment [illegible] right [illegible] generally in good condition. Brush and trees [illegible] on the downstream slope [illegible] distress in the embankment were [illegible].

The [illegible] wall has [illegible] cracking [illegible] spalling. The [illegible] moisture intrusion which has been subjected to alternating freeze and thaw cycles.

2. [illegible] Spillway and Stream [illegible]

[illegible] the [illegible] A vertical crack extends from the apex of the triangularly spalled area [illegible] of the wall. The crack is efflorescent [illegible]. The spalling is attributed to seepage which [illegible] subjected to alternating freeze and thaw cycles.

A horizontal construction joint located approximately 5 feet above the stream bed has [illegible] efflorescence over its entire length. At [illegible] feet downstream from the [illegible] training wall has [illegible] The [illegible] of the base of the wall and seepage at the [illegible] observed [illegible] the [illegible] area.

SECTION 2 - ENGINEERING DATA

[illegible]

A few design drawings and calculations are available [illegible] Water Resources [illegible] of the entire [illegible] varies considerably over its length.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] comprehensive design drawings [illegible] significant shortcoming. [illegible] for availability [illegible] therefore [illegible]

[illegible]

[illegible] in-depth engineering d[illegible] There[illegible] be assessed from the standpoint of [illegible] construction data. This assessment is [illegible] primarily on the visual inspection, past per[illegible] and engineering judgment.

Valid[illegible]

[illegible] the observations of the inspection team [illegible] the limited information contained in the [illegible] NJDEP [illegible] satisfactory evaluation for [illegible]

(4) Gates: One timber waste gate over 5 f[illegible] diameter steel outlet conduit

[illegible] U/S channel: Broad approach fr[illegible]

[illegible] D/S channel: 77 feet wid[illegible]

[illegible]

[illegible] Regulating Outlets

The [illegible] operable regulating outlet is the [illegible] [illegible] in the spillway. It regulates fl[illegible] [illegible] diameter steel outlet conduit with [illegible] [illegible]. The waste gate is operated manually [illegible] [illegible] gear and rack system.

[illegible] Reservoir Surface (acres)

(1) Normal pool [illegible] 54 +

(2) [illegible]

[illegible]

(4) Test flood pool [illegible]

(5) Top dam [illegible]

[illegible]

(1) Type: Concrete gravity and [illegible]

(2) Length: [illegible] feet

(3) Height: [illegible] feet

(4) Top width: [illegible] feet earth embankment

(5) Side Slopes: [illegible] embankments

(6) [illegible]

(7) [illegible] Concrete [illegible]

(8) [illegible]

(9) Grout curtain: None

(10) Other: [illegible]

[illegible] Diversion and Regulating Tunnel: [illegible]

[illegible] Spillway

(1) Type: Concrete gravity

(2) Length of weir: Right section 47.2 feet
Center section [illegible] feet
Left section 24.2 feet

(3) Crest elevation: Right section 137.[illegible]
Center section 13[illegible]
Left section 13[illegible]

(6) Gated spillway capacity at test flood elevation - Not applicable

(7) Total spillway capacity at test flood elevation - Same as (4) above

(8) [illegible] discharge at [illegible] - [illegible]

[illegible] (ft. above MSL)

(1) Streambed at centerline of dam: 1[illegible] ±

(2) [illegible]: 10[illegible] ±

[illegible] portal invert diversion [illegible]

(4) Normal [illegible]: 10[illegible]

[illegible] control [illegible]: N[illegible]

(6) Spillway crest: right section [illegible]
center section [illegible]
left section [illegible]

(7) [illegible] surcharge (original design): Unk[illegible]

[illegible]

[illegible]

[illegible]

(1) Length of maximum pool: 47[illegible] feet ±

(2) Length of normal pool: 43[illegible] feet ±

(3) Length of flood control pool: N[illegible]

[illegible] (acre-feet)

(1) Normal pool: 5[illegible] ±

(2) [illegible] control pool: N[illegible]

(3) Spillway crest pool (lowest section): 50[illegible] ±

(4) Top of dam: 690 ±

(5) Test flood: 830 ±

[illegible] Purpose of Dam

The reservoir impounded by the dam provides a recreational and aesthetic function for the residents of the area.

[illegible] Design and Construction History

According to specifications for the dam dated August [illegible], 1917, the dam was constructed for Arlington Mills of Lawrence, Massachusetts. No major changes were made to the structure, however, the sluice gate was rehabilitated approximately 5 years ago [illegible] [illegible]

[illegible] Operational Procedure

The dam is no longer operated. [illegible] the site weekly and clears brush off the embankment [illegible]. This is the only maintenance [illegible] at the dam.

[illegible]

Drainage Area

The drainage area of the dam is [illegible] square [illegible] rolling terrain. There are numerous small [illegible] and swamps upstream of the dam.

[illegible] Discharge at Damsite

1. Outlet Works

At present there are no operable outlet works at the dam. There is a 5 foot diameter [illegible] duct passing through the spillway with an invert elevation of about 12 [illegible].

2. Maximum flood at damsite - Unknown

[illegible] Spillway capacity at maximum pool elevation [illegible] is 105 [illegible]

Spillway capacity at test flood elevation - [illegible] overtopped by test flood.

[illegible] Gated spillway capacity at normal pool elevation - Not applicable

(5) Left Core Walls and Embankment

The left side of the dam consists of an earth embankment with an eight foot crest width and a concrete core wall. The right portion of this section is approximately 98 feet long and extends along the projection of the spillway axis. The left portion slopes upstream at approximately 45 degrees for a distance of about 15[illegible] feet.

(6) Abandoned Intake Structure

A cellular concrete structure approximately [illegible] feet square is shown on Figure B-2 and [illegible] and is located [illegible] feet upstream from the left end of the spillway. It has been filled with [illegible] and [illegible].

Size Classification

The dam's maximum impoundment of [illegible] acre-feet and hydraulic height of 1[illegible] feet place this dam in the "SMALL" size category as defined in the "Recommended Guidelines".

Hazard Potential Classification

The appropriate hazard potential classification for [illegible] Reservoir Dam is SIGNIFICANT. [illegible] failure of the dam would result in a 1.2 foot rise in [illegible] in the residential development downstream. [illegible] 1 to 2 houses would be flooded, the small rise in water level in the event of a dam failure does not present a significant threat to lives.

Ownership

The dam is owned by the Spicket River Corporation which is located in Lawrence, Massachusetts. The address is 55[illegible] Broadway, Lawrence, Massachusetts, 018[illegible]. Mr. [illegible] is responsible for the dams for the owners and can be reached by telephone at 617-68[illegible]-[illegible].

Operator

Mr. Harman Lowe operates the dam for the owner under the supervision of Messrs. Marlenson and [illegible]. Mr. Lowe's address is Windham Depot Road, RFD 1, Derry, New Hampshire, 03038. His telephone number is 60[illegible]-432-[illegible].

(d) Spillway

This concrete gravity structure is divided into three sections. The right section of the spillway is 23 inches lower than the adjacent embankment section. This yields a crest elevation of 137.5. This section of spillway is 47.[illegible] feet long, and flashboard stanchions are in place at 3[illegible] inches on center. The center spillway section has an overall length of 34 feet with an intermediate pier of 4 feet. The crest elevation of this section is 13[illegible].6. The left spillway section is approximately 2[illegible].2 feet long and has a crest elevation of 1[illegible]. A 2 foot by 2 foot pier divides this portion of the spillway in half. The pier dividing the right and center sections is [illegible] feet long (parallel to the spillway axis) and 5 feet wide. The pier dividing the center and left sections is 11.2 feet long and 5 feet wide.

The waste gate structure located in the spillway is below the pier separating the center and left spillway sections. The structure has a timber sluice gate and a 5 foot diameter steel outlet conduit. Two training walls extend upstream into the impoundment pool on either side of the structure. The top width of these walls is [illegible] feet. These walls are level for about 1[illegible] feet and then slope into the reservoir. Their total length could not be determined. The tops of the walls are approximately 4.6 feet below the left crest level or at elevation 134.[illegible].

(e) Left Spillway End Structure

This concrete gravity structure consists of three sections. The first section is a wall approximately 13 feet long and continues along the spillway axis line. The second section is approximately 15 feet long and is located downstream of the spillway. This section is skewed slightly to the left of the normal to the spillway axis. The third section is approximately 25 feet long and serves as a downstream training wall. This wall skews into the left bank at about a 30 degree angle.

1.2 Description of Project

(a) Location

Millville Reservoir Dam lies on Hittytity Brook which is a tributary of the Spicket River in the town of Salem, N.H. The dam lies about 2 miles upstream from the confluence of Hittytity Brook and the Spicket River. The dam can be reached via an access road located about 750 feet south of the intersection of Millville Street and Bluff Street in Salem, N.H. The portion of the [illegible] Salem Depot, N.H. - Ma. quadrangle presented [illegible] shows this [illegible]. Figure 1 of Appendix B presents a detail of the site developed from the [illegible] and the [illegible].

(b) Description of Dam and Appurtenances

1. General

The dam consists of a three section concrete gravity spillway with a waste gate, a right spillway end structure, a left spillway end structure and concrete core walls extending into the embankments at the left and right ends of the spillway. The overall length of the dam is about [illegible] feet of which the three spillway sections total [illegible] feet. The embankment on the right side extends [illegible] feet before joining the natural ground [illegible].

2. Right Embankments

The right embankment has an 8 foot crest width extending about 60 feet from the end of the spillway before joining natural ground. The earth embankment has a concrete core wall which is 60 feet long.

3. Right Spillway End Structure

This structure is a concrete gravity training wall which is at a right angle to the spillway axis. The concrete core wall connects to the training wall at its upstream end. The training wall is 43 feet long, and the top of the wall slopes downstream at 4 horizontal to 1 vertical. The top width of the wall is 2 feet.

PHASE I INSPECTION REPORT

MILLVILLE RESERVOIR DAM

SECTION 1

[illegible]

1.1 [illegible]

(a) Authority

Public Law 9[illegible]-3[illegible]7, August [illegible], 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZD) has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed was issued to GZD under a letter of November 2[illegible], 197[illegible] from Colonel Max B. Scheider, Corps of Engineers. Contract No. DACW 33-7[illegible]-[illegible] has been assigned by the Corps of Engineers for this work.

(b) [illegible]

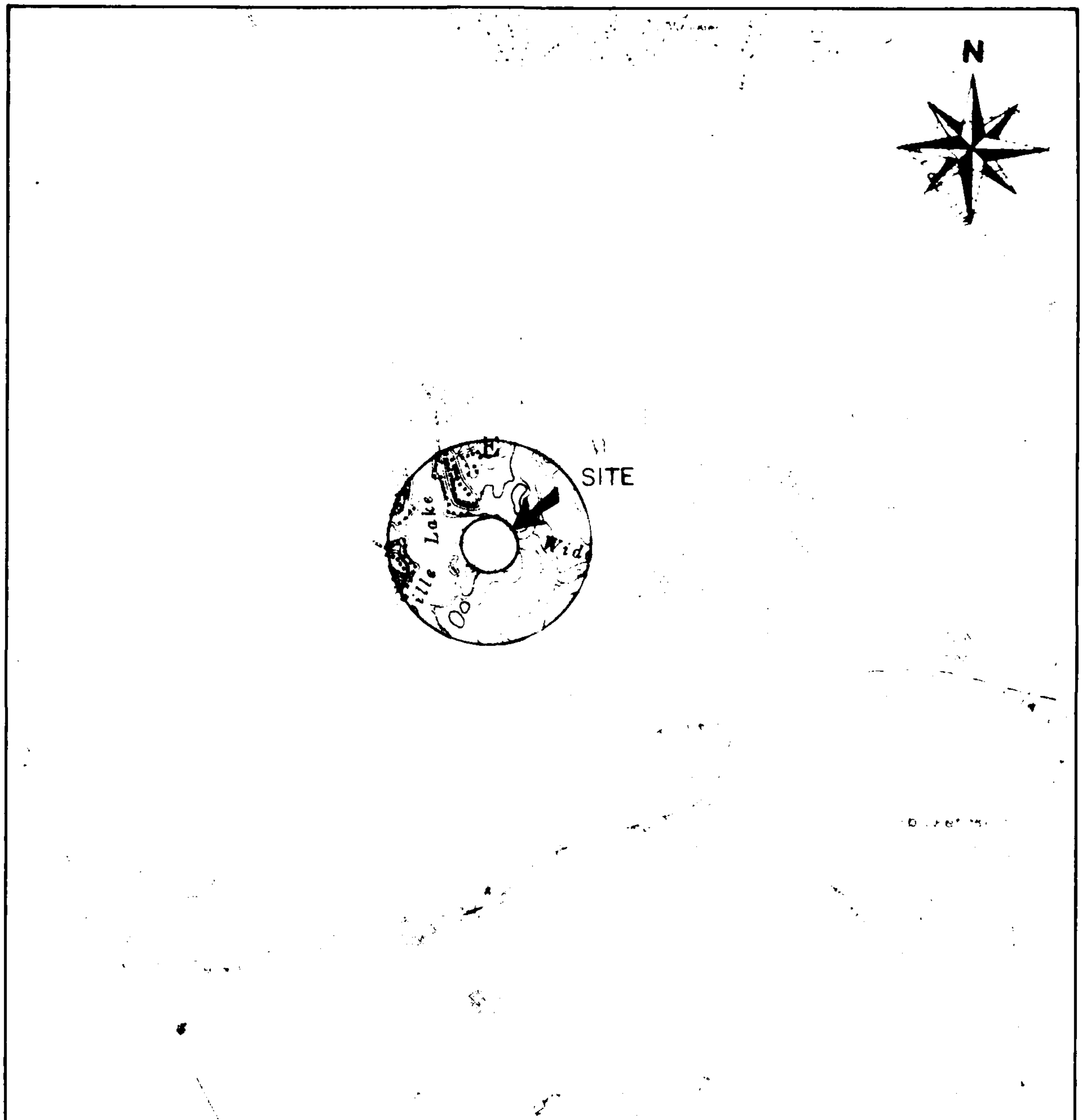
(1) Perform technical inspection and evaluation of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

(2) Encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams.

(3) [illegible]date, verify, and complete the National Inventory of Dams.

(c) [illegible]

The program provides for the inspection of non-federal dams in the high hazard potential category based upon location of the dams and those dams in the significant hazard potential category believed to represent an immediate danger based on condition of the dam.



– SCALE –

0 1000 2000 4000 FT

FROM: USGS SALEM DEPOT, N.H.-
MASS QUADRANGLE MAP

FILE No. 2201

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC GEOTECHNICAL CONSULTANTS NEWTON UPPER FALLS, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCUS PLAN

MILLVILLE RESERVOIR DAM — NEW HAMPSHIRE

SCALE	AS NOTED
DATE	NOVEMBER 1978

3.2 Evaluation

The dam is in poor condition at the present time. The spillway, training walls, and other concrete structures are severely deteriorated and require considerable maintenance. The poor condition of the dam is a result of lack of maintenance. An improved maintenance program is required if the dam is to be maintained in operation.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 [illegible]

At present the [illegible]. Although the [illegible]

4.2 [illegible]

Mr. [illegible] visits the site weekly [illegible]

4.3 [illegible]

[illegible] the Spicket River [illegible] gate was rehabilitated 5 years ago. The gate [illegible]. Cinders have been [illegible] to reduce leakage through the gate.

4.4 [illegible] Warning System

There is no formal warning system in effect for this dam.

4.5 [illegible]

[illegible] long-term use of the [illegible] warning system is recommended because of the possibility of damage to downstream structures in the event of a dam failure.

SECTION 5 - HYDRAULICS/HYDROLOGY

5.1 Evaluation of Features

(a) General

Millville Reservoir Dam is an earth and concrete structure on the Hittytity Brook in Salem, N.H. The reservoir area is approximately 54 acres. The spillway is a 3 level structure with a total length of about 12[illegible] feet. Earth embankments with concrete core walls extend from each end of the spillway. The drainage area is [illegible] square miles of rolling terrain. There are numerous small reservoirs and swamps upstream of the dam.

(b) Design Data

Data sources available for Millville Reservoir Dam include prior inventory and inspection reports. Much of the basic data on the dam is contained in the New Hampshire Water Control Commission's "Data on Dams in New Hampshire" (July 1[illegible], 19[illegible]), the New Hampshire Water Resources Board's "Inventory of Dams and Water Power Developments" ([illegible] 3[illegible], 1977), and the Public Service Commission of New Hampshire's "Dam Record" (November 6, 1935). Inspection reports dated June 2[illegible], 1940; July 25, 1941; December 1[illegible], 19[illegible]; August 1[illegible], 1967; August 26, 1971; November 17, 197[illegible]; and [illegible] 1973 are available as are numerous letters pertaining to the condition of the dam.

The construction specifications and some sketches from 1917 are available. Calculations from a 1975 study of the dam's stability are also available.

(c) Experience Data

No records of flow or stage are known to be available for Millville Reservoir Dam.

(d) Visual Observations

The reservoir has an area of about 54 acres. The pond is surrounded by homes, most of which were formerly used only during the summer but which are now used year-round. Many of the houses near the dam have ground floor elevations nearly equal to the top of the dam. Overtopping of the dam would also be accompanied by partial flooding of these houses.

The channel downstream of the dam becomes part of the Widow Harris Brook which joins the Spicket River about 1-1/4 miles downstream of the dam. Immediately downstream of the dam the channel is about 75 feet wide and flows for about 50 feet before entering a swamp-like area. A residential area of Salem [illegible] this area with many residences in the flood plain of the Widow Harris Brook.

The water elevation downstream of the dam is controlled by a culvert under one of the roads in the [illegible] area. The culvert is circular with a [illegible] diameter. At present about half of the culvert is [illegible] by sediment. The roadway is about 5 feet above [illegible] the culvert.

From this point the Widow Harris Brook flows through [illegible] of swampy areas and culverts. A total of [illegible] culverts and swampy areas were encountered in the 1-1/4 mile stretch between the dam and the Spicket River. The area around the swamps is extensively developed with many residences along the edges.

Test Flood Analysis

The hydrologic conditions of interest in the Phase I investigation are those required to assess the dam's [illegible] potential and its ability to safely allow an appropriately large flood to pass. This requires that the discharge and storage characteristics of the structure [illegible] evaluate the impact of an appropriately sized Test Flood. None of the original hydraulic and hydrologic design records are available for use in this study.

Guidelines for establishing a recommended Test Flood based on the size and hazard classification of a dam are specified in the "Recommended Guidelines" of the Corps of Engineers. The impoundment of 690 acre-feet and height of 18 feet classify this dam as a SMALL structure.

The appropriate hazard classification for this dam is SIGNIFICANT. If Millville Reservoir Dam were to fail, there would be a noticeable increase in the [illegible] in the residential development downstream of the dam. Although property damage caused by a failure would be high, the small rise in water level does not present a large threat of loss of life.

As shown in Table 3 of the Corps of Engineers' "Recommended Guidelines," the appropriate Test Flood for a dam classified as SMALL with a SIGNIFICANT hazard classification is between the 100 year flow and one-half of the Probable Maximum Flood (PMF). Since the hazard classification is on the high side of the SIGNIFICANT category, one-half of the PMF [illegible] for use as the Test Flood for this Dam.

The rolling terrain upstream of the dam, interspersed with swamps and ponds, indicates a one-half PMF flow of about 500 cubic feet per second per square mile. For the [illegible] square mile drainage area, this yields a peak flow to the reservoir of 505[illegible] cfs. This [illegible] be attenuated by storage in Millville Reservoir and the peak outflow would be about 4[illegible] cfs [illegible] level [illegible] feet above the minimum spillway elevation [illegible] 1[illegible]. This water level is 2.2 feet above the right embankment and 1.4 feet above the left embankment. The spillway capacity is only 1050 cfs which is [illegible] of the test flood.

[illegible] Failure Analysis

The peak [illegible] that would result from a failure [illegible] dam is estimated using the procedure [illegible] the Corps of Engineers New England Division [illegible] Guidelines for Estimating [illegible] [illegible] 7, 1978 [illegible]. Failure is assumed to occur [illegible] water surface elevation at the top of the right [illegible] [illegible] feet above the minimum spillway crest [illegible]

The discharge prior to failure with the water level at the dam crest would be 1050 cfs as determined from the stage-discharge curve as described in Appendix [illegible]. The tailwater prior to failure would be 130.5 feet MSL, [illegible] [illegible] the spillway crest. This would be [illegible] feet [illegible] and would cause some flooding [illegible] 1.4 mile downstream [illegible]

With a ninety-six foot gap opened in the dam, failure would cause the flow to increase by 429 cfs to a total of 1340 cfs. This would cause the tailwater to rise 1.2 feet to 131.7 feet (MSL). This increase to the level of flooding in the residential area downstream of the dam would be significant as there are about 10 to 2[illegible] houses around elevation 130 feet (MSL).

The nature of the downstream area places the safety of this dam in a more critical light. The floodplain area is the backyard of numerous new homes, housing mostly families with young children. If the dam were to fail under normal conditions, not during a major flood event, there is a chance that children would be playing in the downstream area. This [illegible] does not merit the HIGH hazard classification, but it does require a thorough hydrologic examination for this dam.

The topographic data and flow routing procedures used in this study were appropriate to a Phase I study and represent approximations based from a [illegible] quadrangle sheet and similar data sources. It is recommended that [illegible]

SECTION C - STRUCTURAL STABILITY

C.1 Evaluation of Structural Stability

(a) Visual Observations

1 [illegible]

The field investigation revealed seepage flowing through the right and left spillway sections and the left and right training walls. These [illegible] warrant further investigation [illegible] structural stability [illegible]

[illegible]

The right section of the spillway is eroded [illegible] and effloresced. Two eroded pockets were [illegible] in the spillway section, and seepage [illegible] through one of the pockets at the [illegible] The pier separating the right and center spillway sections is also eroded.

The center spillway section has several [illegible] with seepage flowing [illegible] The intermediate pier is eroded [illegible] and on its upstream [illegible]

The left spillway section is spalled [illegible] percent of its surface area. The concrete [illegible] is undermined where it joins the original spillway crest, and seepage was observed at this interface. Many effloresced random cracks were observed on this spillway section.

2 Gate Structure

The concrete on the waste gate structure [illegible] and rusted reinforcing [illegible] exposed. [illegible] rusted through [illegible] and seepage was observed [illegible] the gate.

3 Downstream Training Walls

The right downstream training wall is spalled and eroded in several places. Seepage was observed at two separate places through the wall, and many other cracks are effloresced.

The left downstream training walls are severely spalled. Seepage was observed through a portion of the wall, and large diagonal cracks have developed at the interface between the [illegible] downstream wall sections.

[illegible]

No plans or calculations of value to a stability assessment are available for this dam.

[illegible]

No operating records of value to a stability [illegible] are available for this dam.

. Post Construction Changes

The [illegible] construction changes at the dam [illegible] have affected the stability of the [illegible].

. Seismic Stability

The dam is located in Seismic Zone No. 2 [illegible] [illegible] with recommended Phase I guidelines [illegible] [illegible] analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

[illegible]

The [illegible] Reservoir Dam is in POOR condition at the present time. The seepage through the concrete spillway and both training walls should be brought under [illegible] to prevent further concrete deterioration. The [illegible]

[illegible]

[illegible] in-depth engineering data [illegible] permit a definitive review. Therefore, the [illegible] be assessed from the standpoint [illegible] data. This assessment [illegible] the visual inspection [illegible] engineering judgment.

[illegible]

[illegible]

[illegible] Investigations

Additional investigations should be performed [illegible] outlined in Paragraph 7.2 [illegible]

7.2 Recommendations

It is recommended that the services of a registered [illegible] engineer be retained to:

[illegible] the [illegible] undertake [illegible] the source of seepage through the spillway [illegible] training walls [illegible] to determine [illegible] and proper method of sealing the [illegible] the abandoned intake structure, and [illegible] the structural adequacy of the waste gate structure.

Perform further hydrologic and hydraulic studies to determine the need for additional spillway capacity.

[illegible] of section 75 feet downstream and 25 feet left of the left downstream [illegible]

Prepare plans for repair of all deteriorated [illegible] of the spillway and training walls.

The owner should implement the findings of the [illegible]

[illegible]

[illegible]

[illegible] trees from downstream [illegible] with [illegible]

[illegible] from downstream channel.

[illegible] program of annual technical [illegible]

[illegible]

[illegible]

[illegible] alternative to the above recommendation [illegible] the dam after drawing down the [illegible] However [illegible] many homes are located around the [illegible] breaching the dam may not be a realistic alternative.

APPENDIX A

VISUAL INSPECTION CHECKLIST

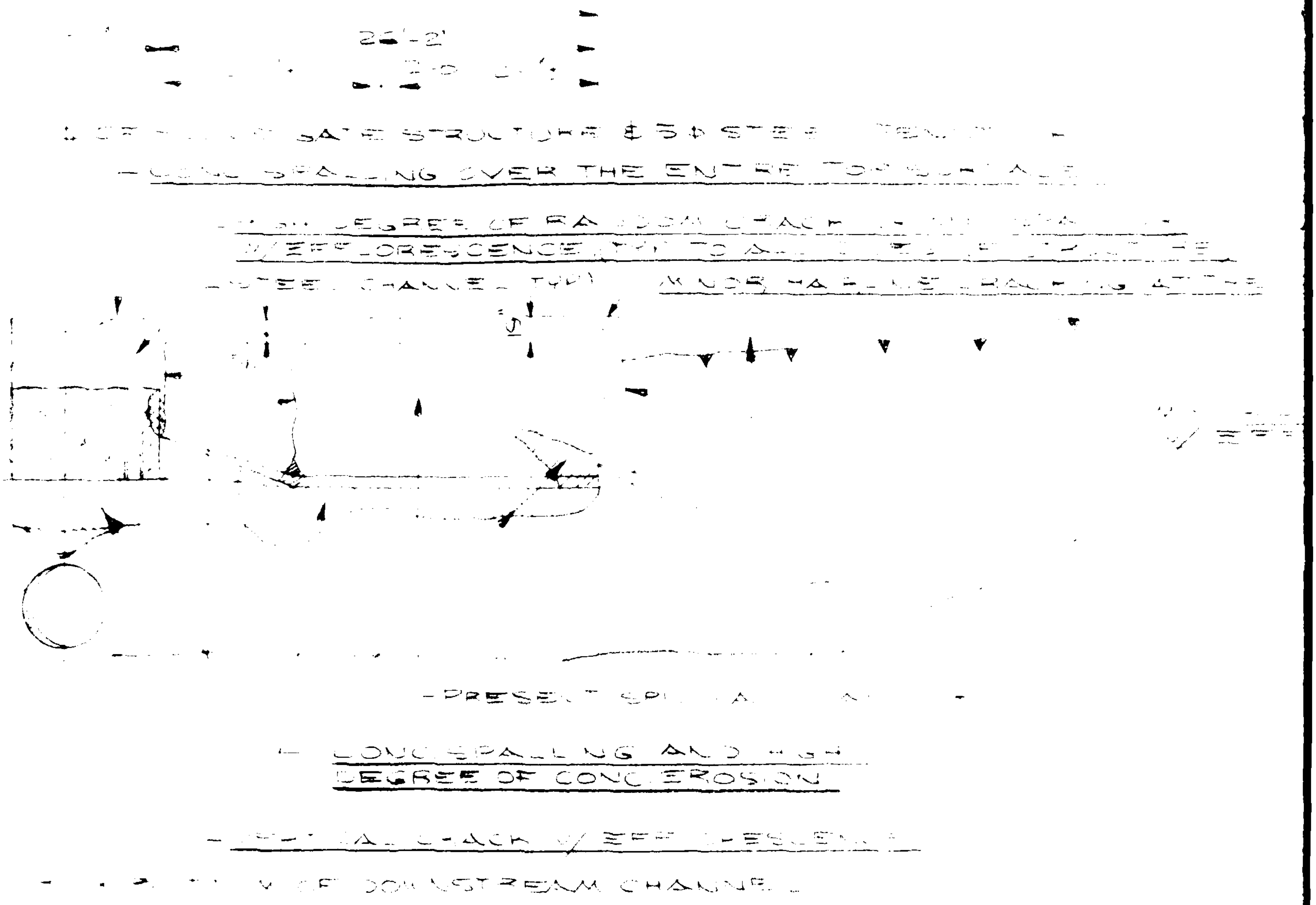
[illegible]

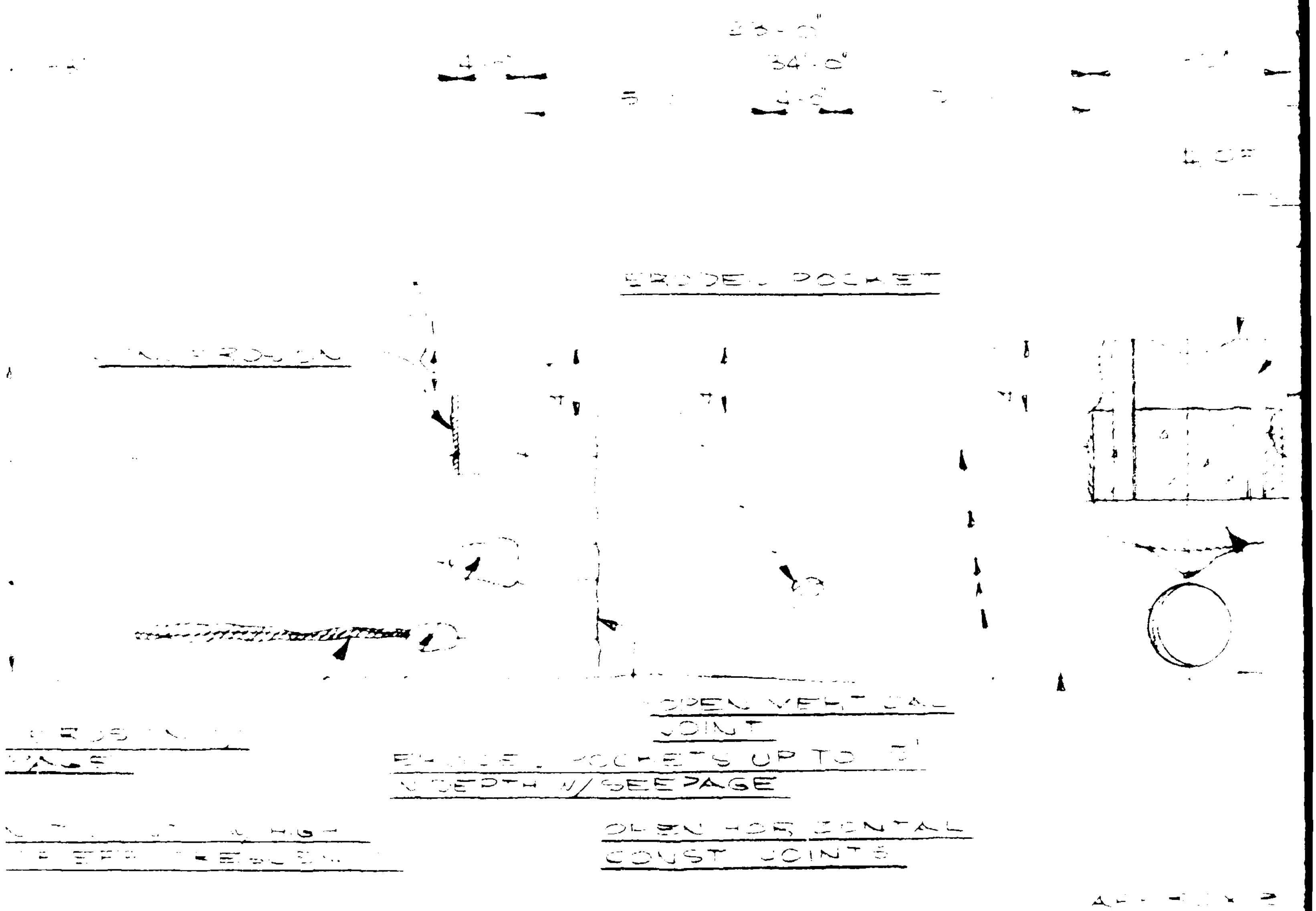
CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible] centerline approximately [illegible] in diameter. Approximately [illegible] this area. Impossible to [illegible] whether [illegible] is [illegible] [illegible] area.

CHECK LISTS FOR VISUAL INSPECTION

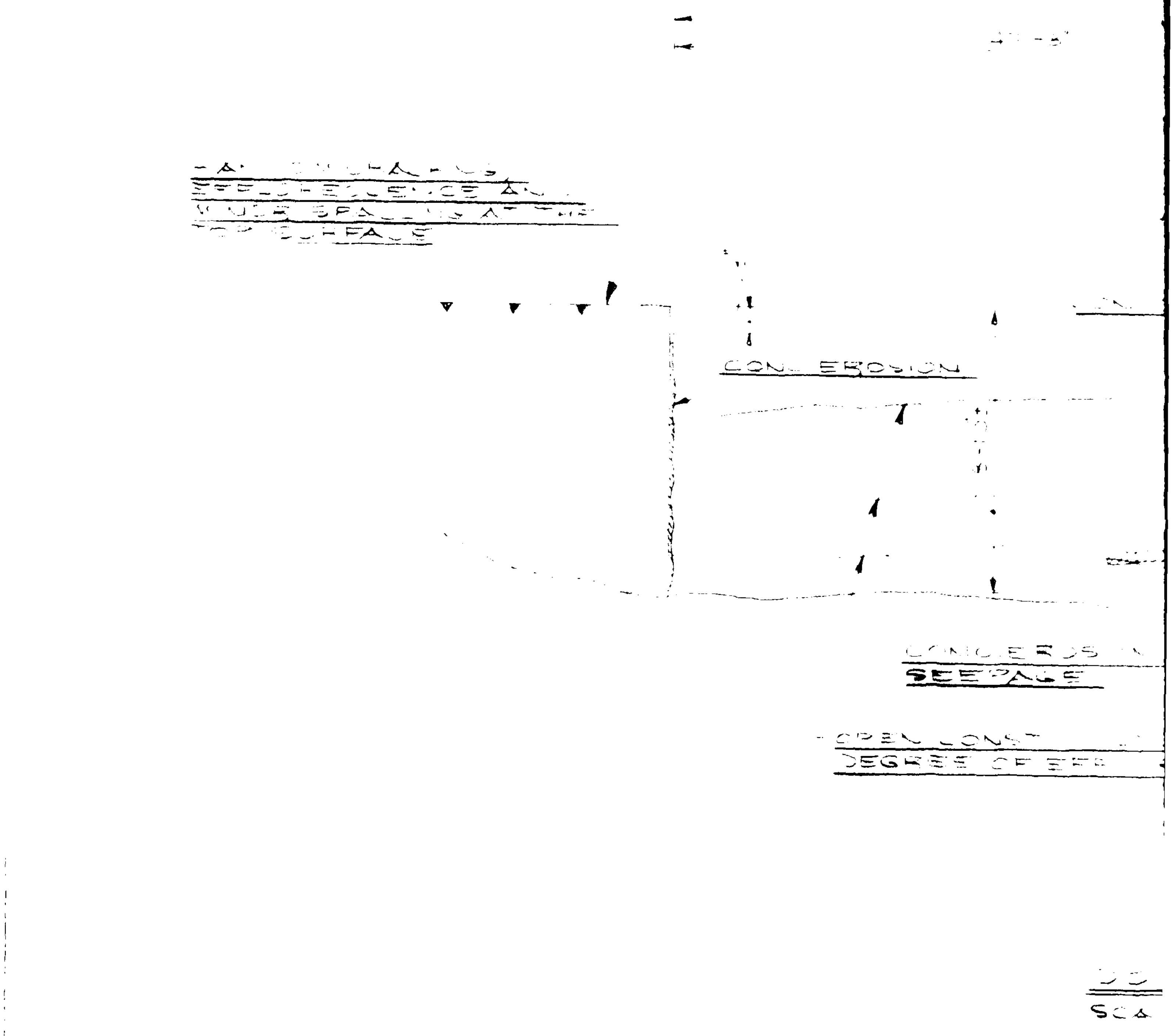
AREA EVALUATED	BY	CONDITION & REMARKS
[illegible]	NPC	[illegible]
[illegible]	NPC	[illegible]
[illegible]	PC	[illegible]
[illegible]		[illegible] Vertical cracks [illegible]
[illegible]		[illegible] spalled [illegible] over [illegible]
[illegible]		[illegible]

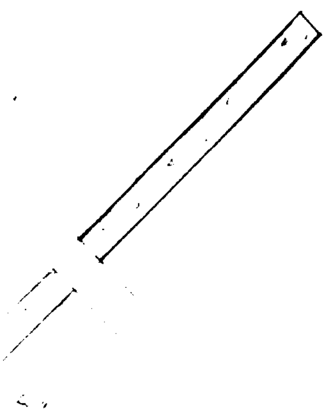

26'-2"
GATE STRUCTURE
OVER THE ENTIRE
DEGREE OF RA
W/ EFFLORESCENCE
CHANNEL
MINOR
PRESENT
SPALLING AND
DEGREE OF CONC EROSION
CRACK W/ EFF
DOWNSTREAM CHANNEL



DOWNSTREAM ELEVATION

SCALE: 1/8" = 1'-0"


CONC EROSION
SEEPAGE



NOTES

1. DAM INSPECTED ON NOVEMBER 1, 1978 BY GOLDBERG, ZOINO, DUNNICLIFF AND ASSOC., INC.

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC GEOTECHNICAL CONSULTANTS NEWTON UPPER FALLS, MASS	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

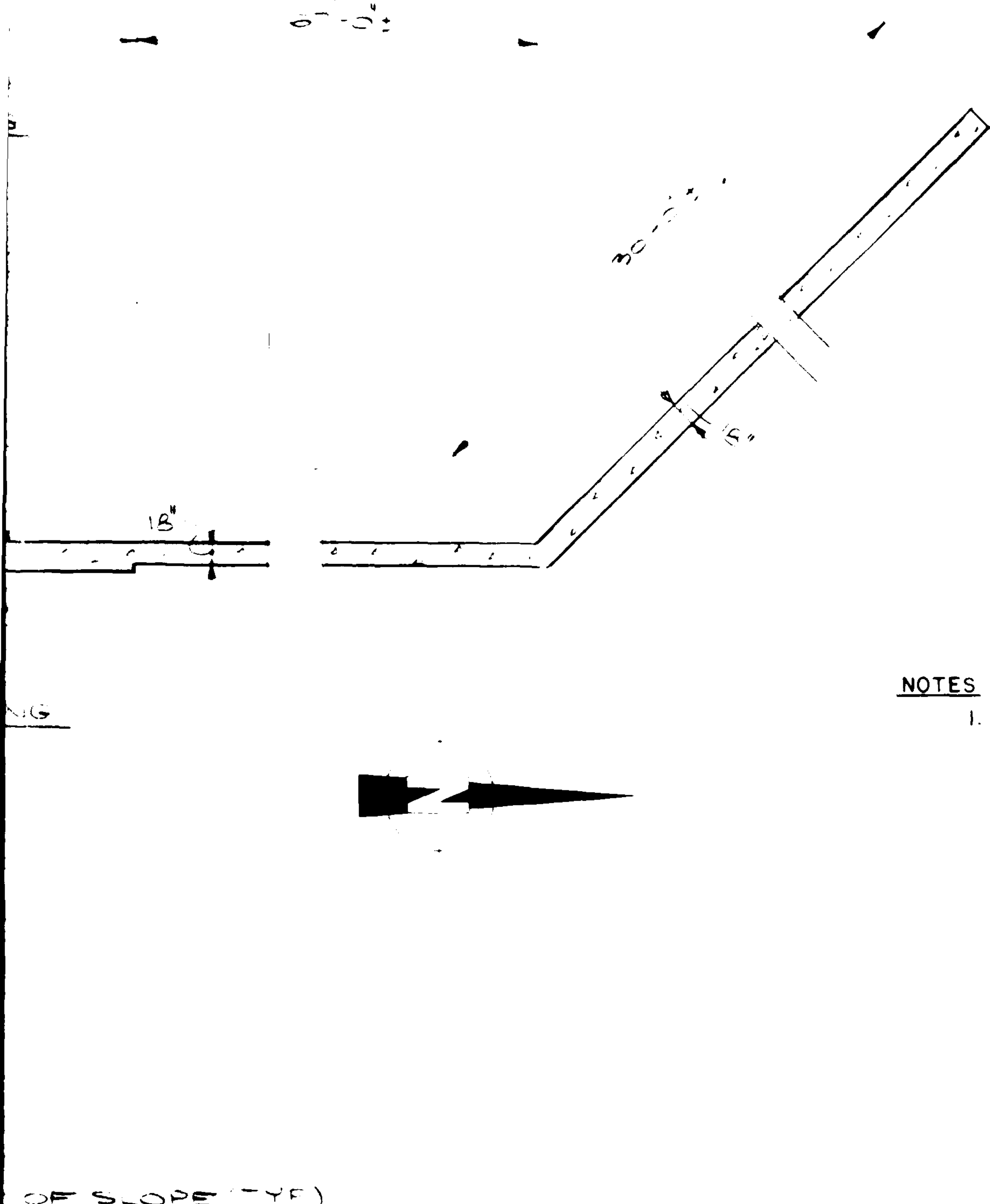
FIGURE 2

PLAN OF DAM

MILLVILLE RESERVOIR DAM — NEW HAMPSHIRE

SCALE [illegible]

DATE NOVEMBER 1978



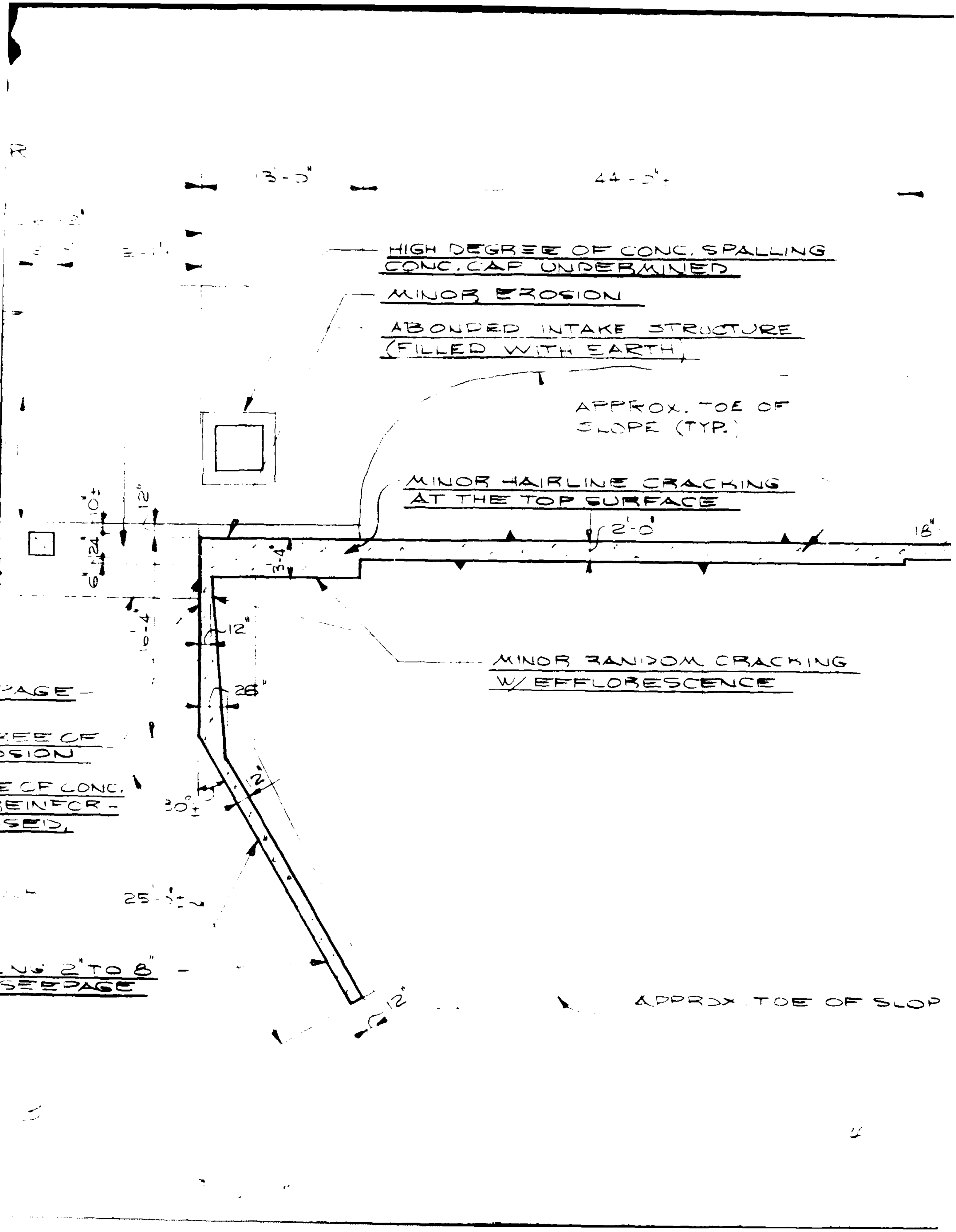
NOTES

1. DAM INSPECTED ON NOVEMBER 1, 197
AND ASSOC., INC.

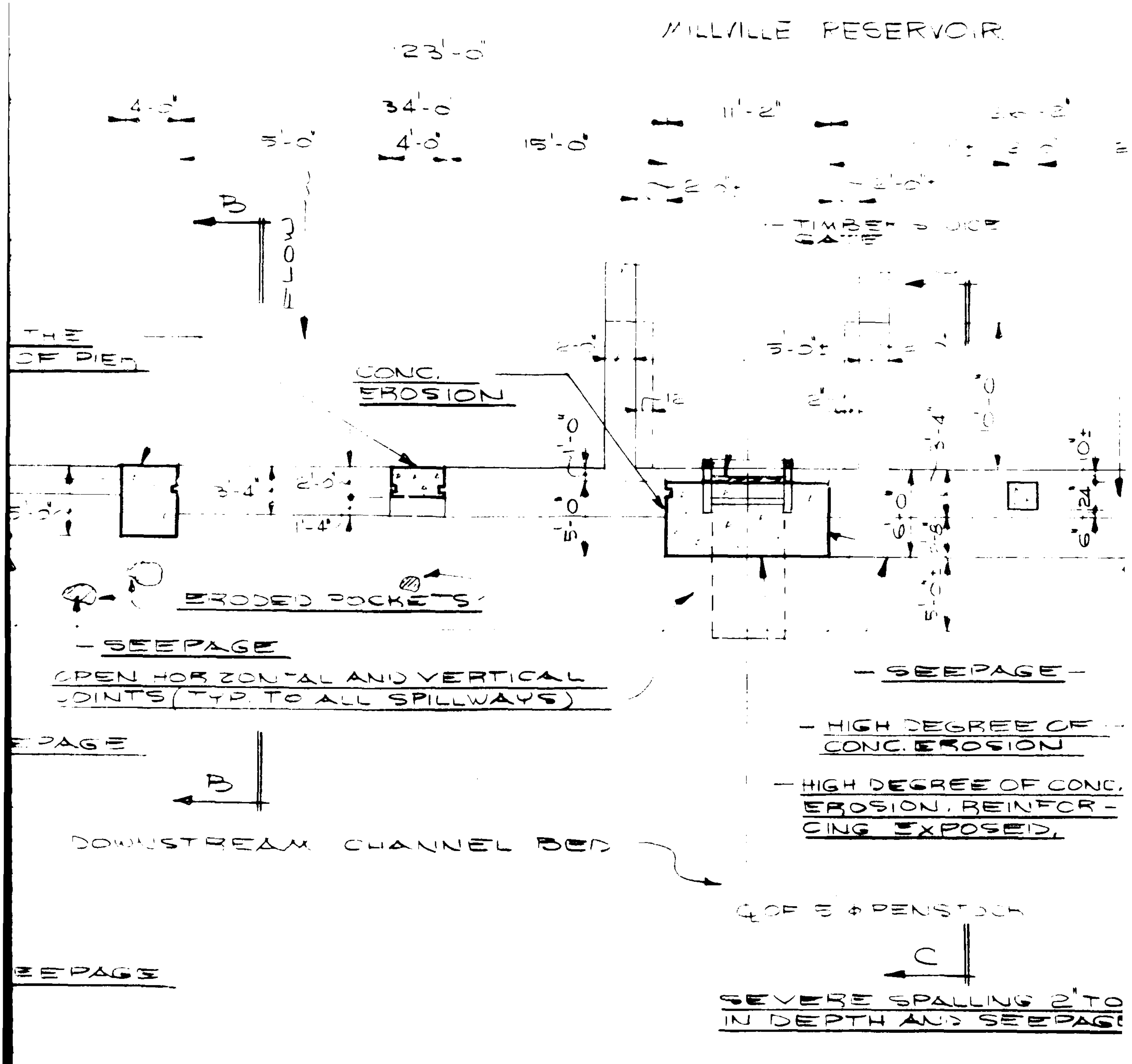
GOLDBERG, ZOINO
GEOTECHNICAL
NEWTON UPPER

NATIONA

MILLVILLE

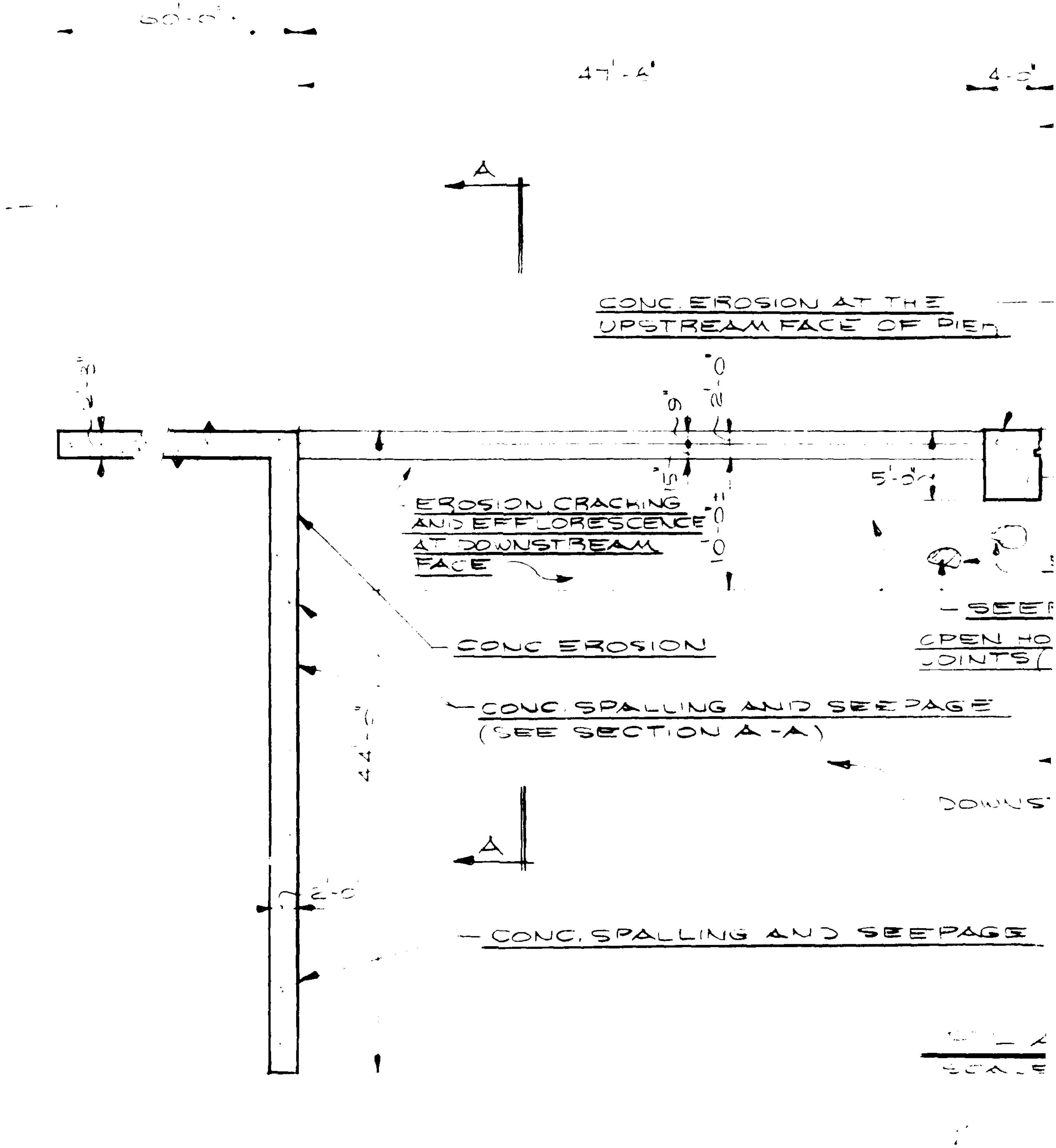


3'-0"
44'-0"±
HIGH DEGREE OF CONC. SPALLING
CONC. CAP UNDERMINED
MINOR EROSION
ABONDED INTAKE STRUCTURE
(FILLED WITH EARTH)
APPROX. TOE OF
SLOPE (TYP.)
MINOR HAIRLINE CRACKING
AT THE TOP SURFACE
2'-0"
18"
10"±
12"
24"
6"
3'-4"
12"
26"
MINOR RANDOM CRACKING
W/ EFFLORESCENCE
PAGE
REE OF
OSION
E OF CONC.
REINFOR-
OSED.
30°±
12"
25'-0"±
NG 2" TO 8"
SEEPAGE
12"
APPROX. TOE OF SLOP

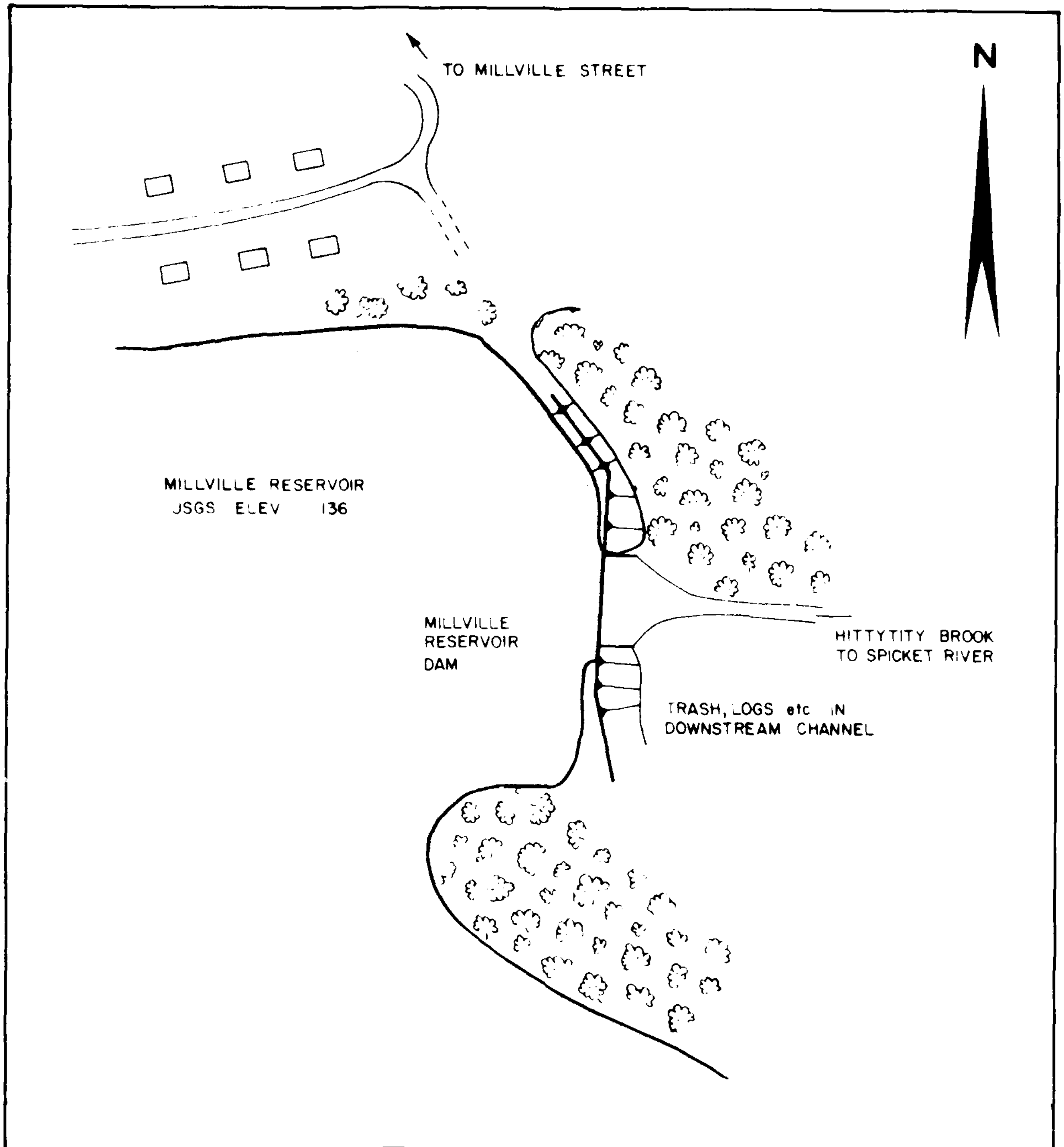


PLAN

SCALE 1/8" = 1'-0"



50'-0"
47'-4"
4'-0"
A
CONC. EROSION AT THE UPSTREAM FACE OF PIER
2'-3"
9"
2'-0"
1'-5"
5'-0"
10'-0"
EROSION CRACKING AND EFFLORESCENCE AT DOWNSTREAM FACE
CONC. EROSION
SEEP
OPEN HO
JOINTS(
CONC. SPALLING AND SEEPAGE (SEE SECTION A-A)
44'-0"
DOWNS
A
2'-0"
CONC. SPALLING AND SEEPAGE
SCALE



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NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

SITE PLAN

FILE No. 2201

MILLVILLE RESERVOIR DAM — NEW HAMPSHIRE

SCALE 1" = 200'

DATE NOVEMBER 1978

APPENDIX B

CHECK LISTS FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITION & REMARKS
B. Waste Gate Outlet Structure		
Condition of concrete	PC	Very poor
Spalling		Intensive. Downstream [illegible] spalled over 75 [illegible] up to 5" deep. Downstream right corner spalled [illegible] base to abutment spillway [illegible] up to 12" thick. Top surface completely spalled
Erosion		Left downstream corner [illegible] 4' high x 18" wide and 6" [illegible]
Cracking		High degree of random cracking over entire left face
Rusting or staining of concrete		Back face stained [illegible] exposed reinforcing [illegible]
Visible reinforcing		Exposed rusted woven wire fabric over 75 [illegible]
Efflorescence		Left face highly efflorescent
Seepage		Through and around timber sluice gate at the rate of [illegible] to 10 gpm
[illegible]		Five rusted [illegible] 1" [illegible] and 6" high at both sides [illegible] downstream channel water [illegible]
[illegible] gate		Operable but not operated. Handwheel not available. No provisions for trash racks or stoplogs
C. Overflow Structure		
Condition of concrete	PC	Structure abandoned. Subjected to differential settlement in the range of 6". Filled with earth

MILLVILLE RESERVOIR DAM
Salem, N.H.

NH 00030
November 1, 1978

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Cracking	PL	Five (5) open horizontal joints and one open vertical construction joint
Rusting or staining of concrete		None noted
Visible reinforcing		None noted
[illegible]		None noted
Seepage		Seepage flowing [illegible]
[illegible]		
Condition of [illegible]		[illegible]
Spalling		[illegible] spalled [illegible]
[illegible]		See spalling
Cracking		Random horizontal and vertical cracks over entire [illegible] face
Rusting or staining of concrete		None noted
Visible reinforcing		None noted
[illegible]		High degree of [illegible] and exudation at [illegible] areas. Minor at random vertical and horizontal cracks
Seepage	PL	Along entire interface of dam and spillway at the rate of 1 to 2 gpm

MILLVILLE RESERVOIR DAM
[illegible], N.H.

NH 00030
November 1, 1978

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
[illegible]		
[illegible]		
[illegible]		
[illegible]	FK	[illegible]
		Two [illegible] 2' high x 1[illegible] deep and [illegible] x 2' high x 12 deep [illegible] long 2' high x 6 deep [illegible]
Erosion		See spalling. [illegible] eroded at intermediate [illegible] spillway crest [illegible] corners completely [illegible] height [illegible]
Cracking		Horizontal construction [illegible] cracked. [illegible] hairline [illegible]
[illegible]		None noted
[illegible]		None noted
Efflorescence		Horizontal construction joints highly effloresced. Vertical hairline cracks effloresced.
Seepage		Seepage at the rate of [illegible] flowing [illegible] pocket
Center section		
Condition of concrete		Poor
Spalling		See erosion
Erosion	FK	Intermediate pier eroded over entire upstream face.

[illegible] RESERVOIR [illegible]
Salem, N.H.

NH 00086
November 1, 1978

CHECK LISTS FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITION & REMARKS
Cracking	FC	Two full height diag[illegible] cracks at interfa[illegible] ment and downstream [illegible] wall. Minor hairline [illegible] random cracks [illegible]
[illegible]		None noted
[illegible]		None noted
[illegible]		Min[illegible] abutment
[illegible]		Steady seep[illegible] location. [illegible]
[illegible]		
[illegible]		[illegible]
[illegible]		Intr[illegible]
[illegible]		None noted
Cracking		Intermittent [illegible]
[illegible]		None noted
[illegible]		None noted
Efflorescence		None noted
Seepage	FC	None noted

RE

AT THE TOP SURFACE

MINOR RANDOM CRACKING
W/ EFFLORESCENCE

NOTE

5

NOTES

1. DAM INSPECTED ON NOVEMBER 1, 1978 BY GOLDBERG, ZOINO, DUNNICLIFF AND ASSOC., INC

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC GEOTECHNICAL CONSULTANTS NEWTON UPPER FALLS, MASS	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

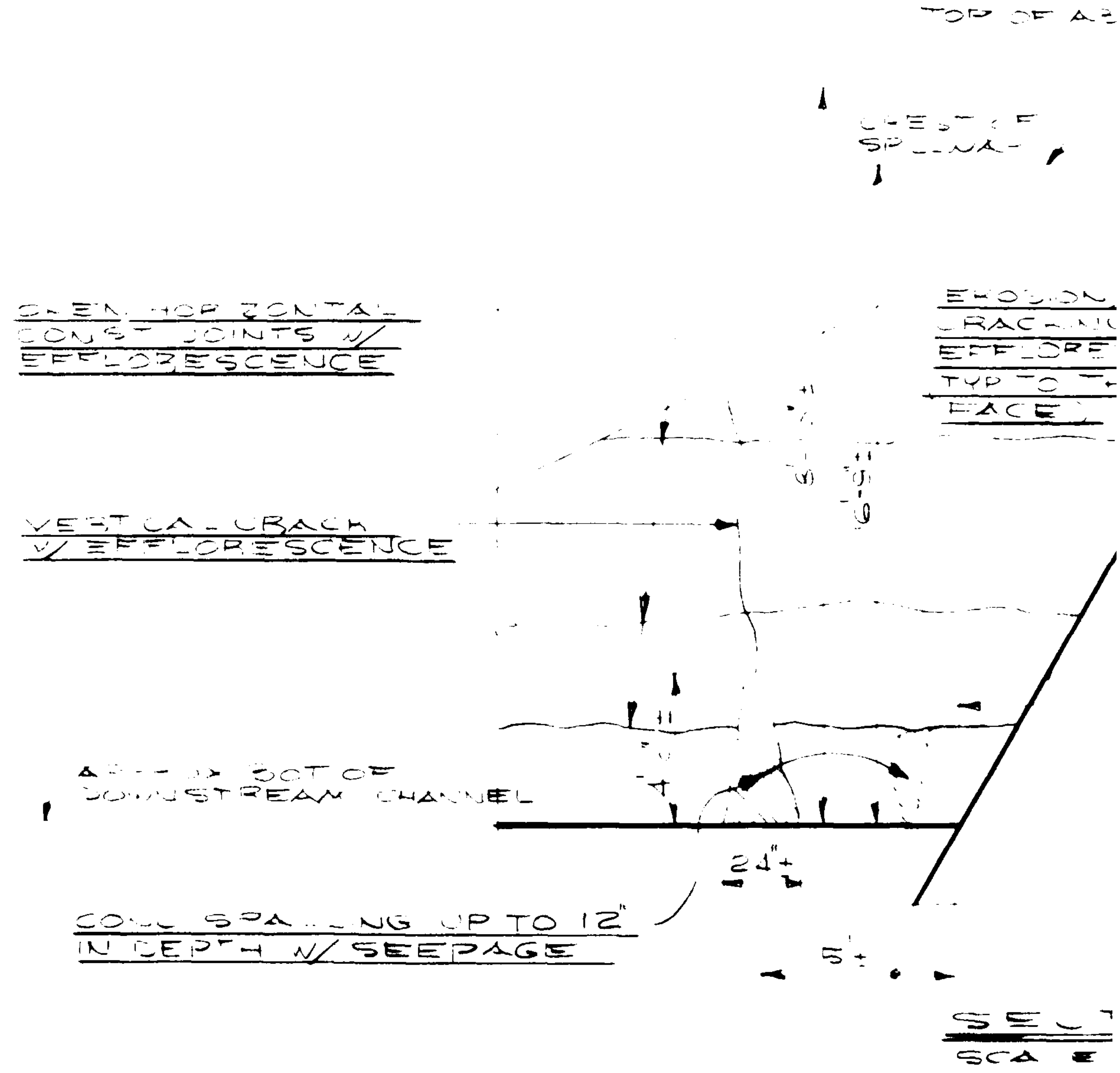
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

FIGURE 3

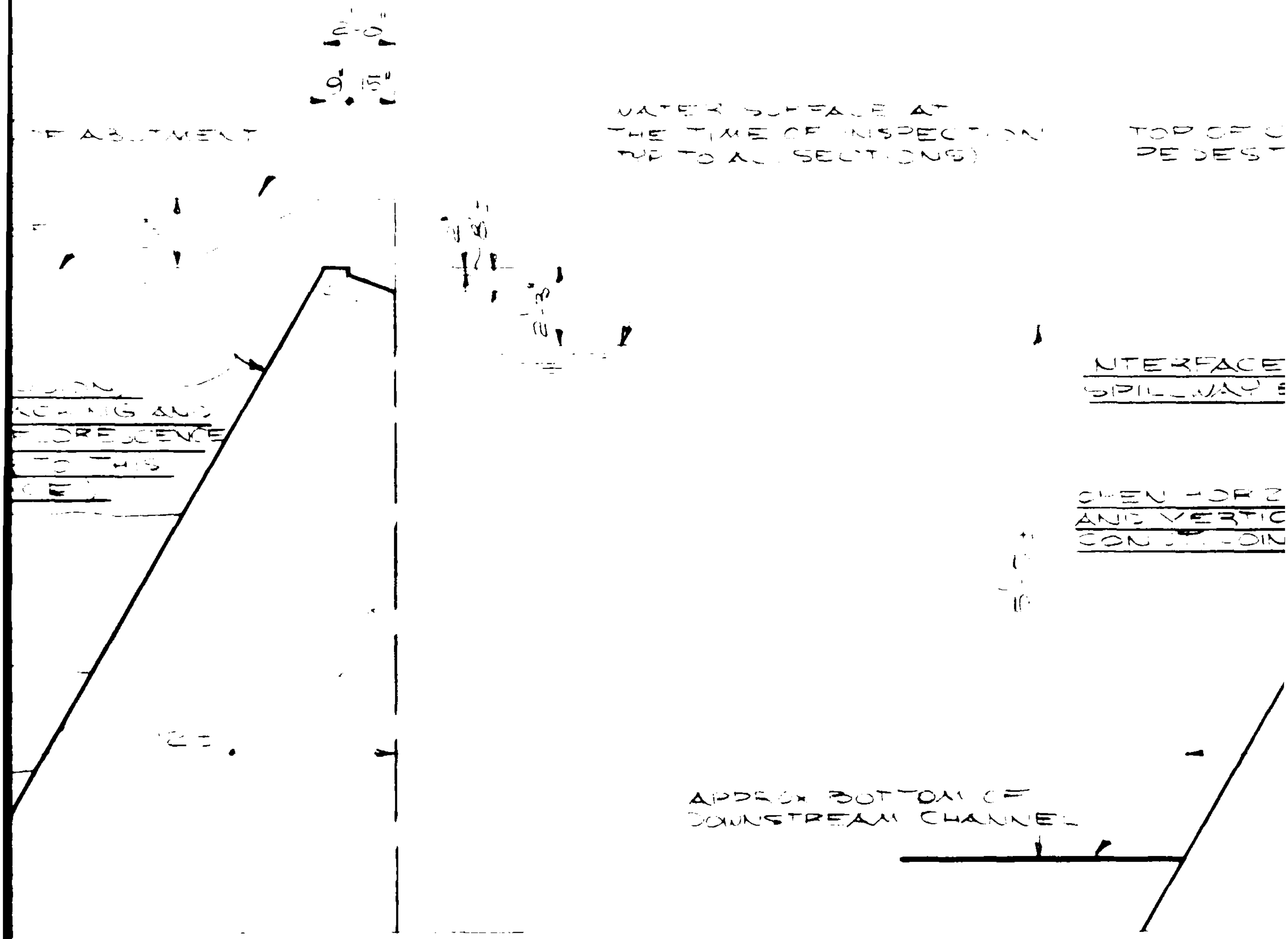
DOWNSTREAM ELEVATION

MILLVILLE RESERVOIR DAM — NEW HAMPSHIRE

			SCALE 1/8" = 1'
			DATE NOVEMBER 1978

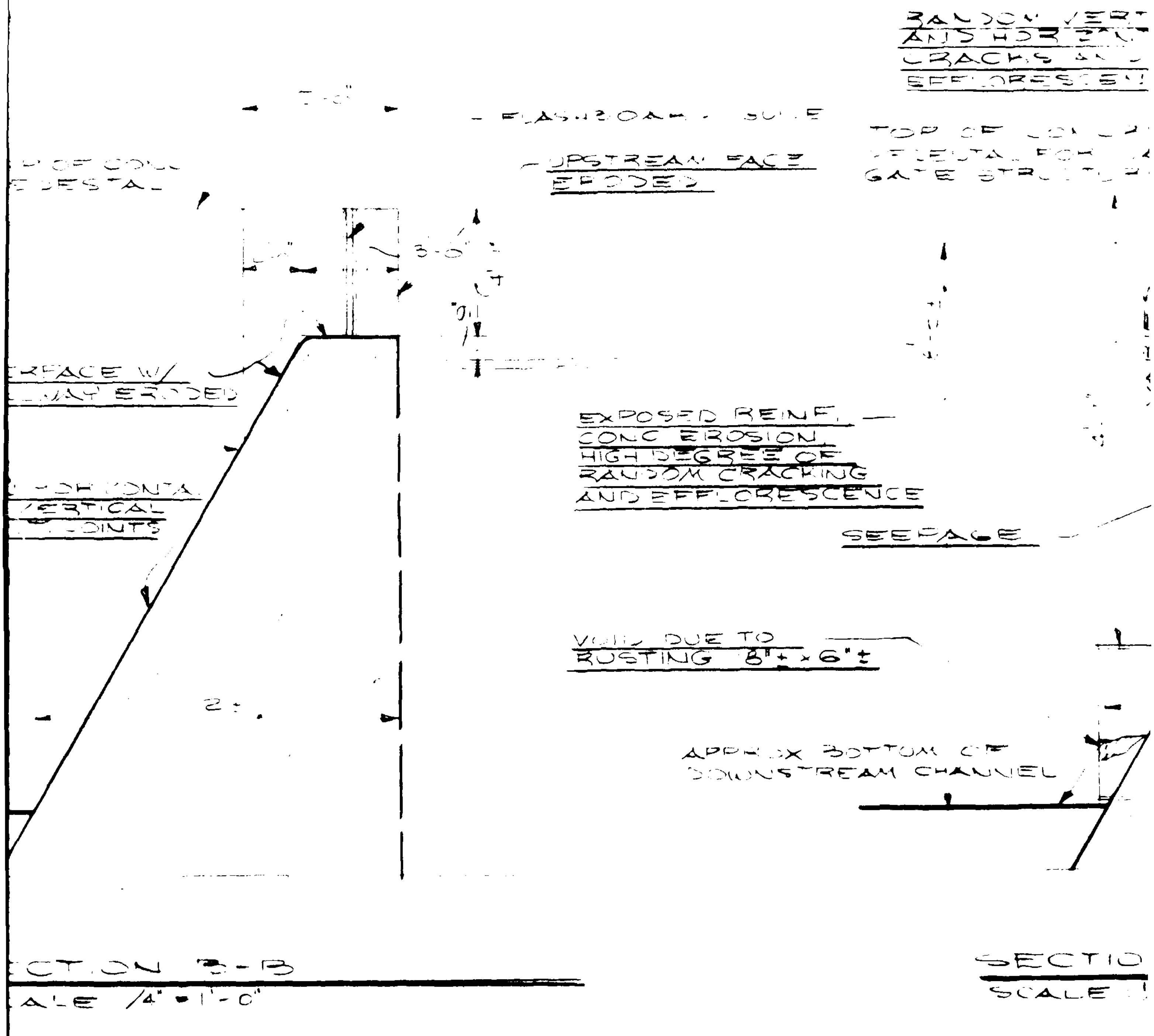


CONST JOINTS W/
EFFLORESCENCE
VERTICAL CRACK
W/ EFFLORESCENCE
DOWNSTREAM CHANNEL
24"±
UP TO 12"
IN DEPTH W/ SEEPAGE
5'±



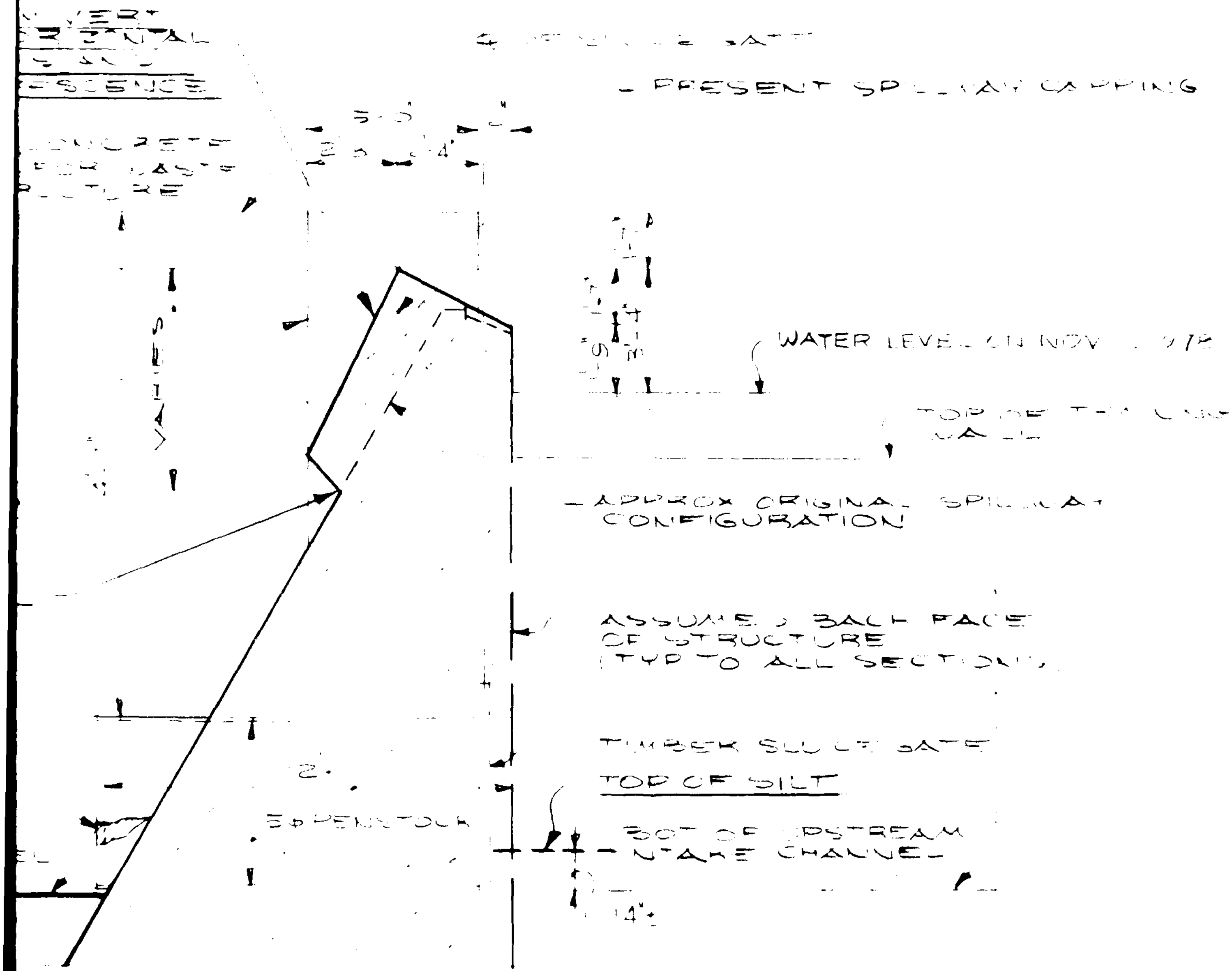
ECTION A-A
SCALE 1/4" = 1'-0"

SECTI
SCALE



UPSTREAM FACE ERODED
EXPOSED REINF.
CONC EROSION.
HIGH DEGREE OF
RANDOM CRACKING
AND EFFLORESCENCE
SEEPAGE
VOID DUE TO
RUSTING 8"± x 6"±
APPROX BOTTOM OF
DOWNSTREAM CHANNEL
GATE STRU
SECTIO
SCALE

4



NOTES

ECTION C - C

ALE 1/4" = 1'-0"

NOTES

1. DAM INSPECTED ON NOVEMBER 1, 1978 BY GOLDBERG, ZOINO, DUNNICLIFF AND ASSOC., INC.

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC GEOTECHNICAL CONSULTANTS NEWTON UPPER FALLS, MASS	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

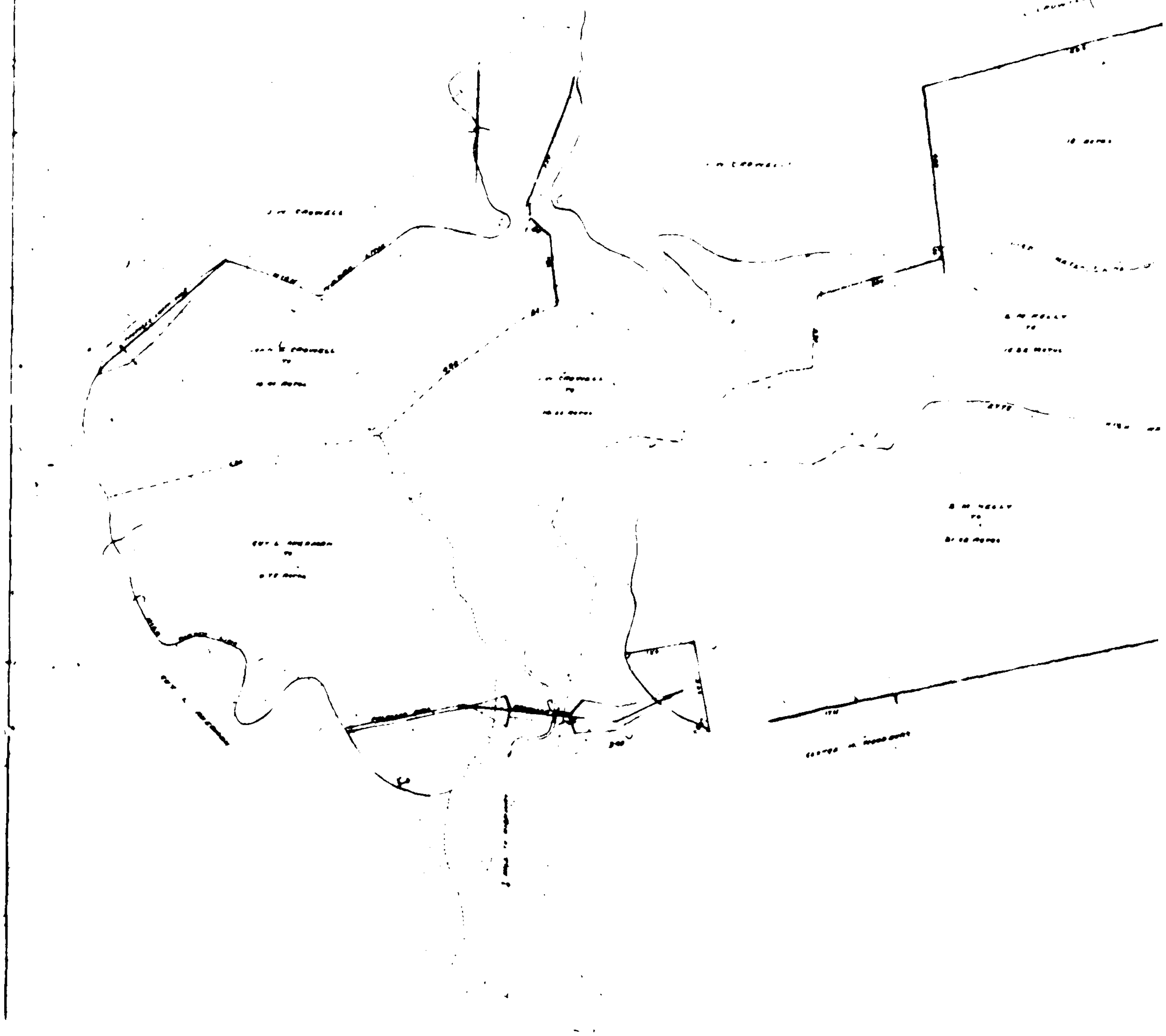
FIGURE 4

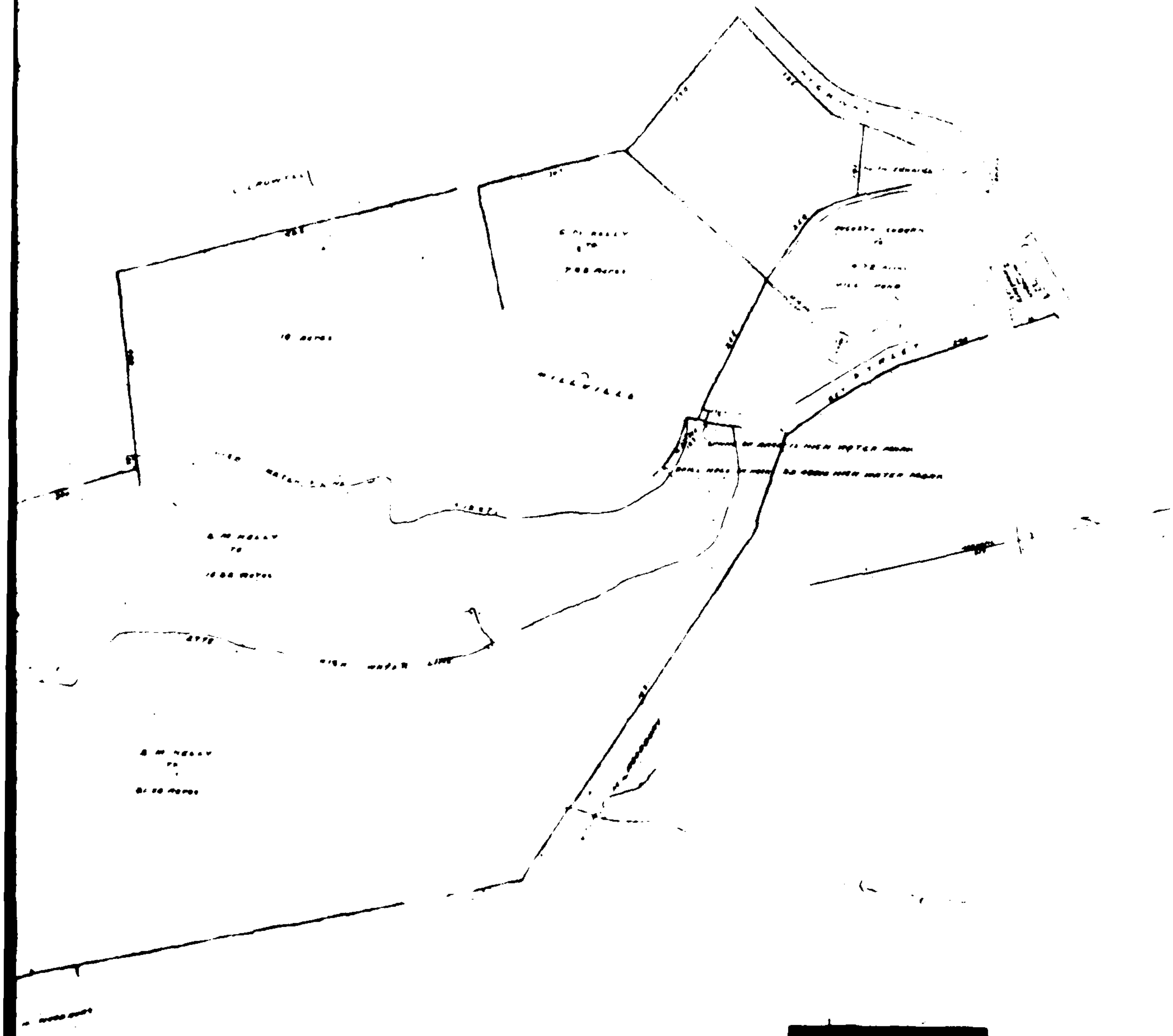
SECTIONS OF DAM

MILLVILLE RESERVOIR DAM NEW HAMPSHIRE

SCALE 1/8" = 1'

DATE NOVEMBER 1978





[redacted]

ARLINGTON MILLS
LAWRENCE, MASS
PLAN OF WATER PRIVILEGE AT MILLVILLE
SALEM, N.H.

MILLVILLE RESERVOIR

The New Hampshire Water Resources Board (NHWRB) [illegible] at 37 Pleasant Street, Concord, N.H., 03[illegible] maintains a comprehensive [illegible] for the dam. Included [illegible]

1. Inspection reports dated June 25, 194[illegible]; July [illegible] 19[illegible]; December 1, 1944; August 13, 19[illegible]; August [illegible], 1971; November 17, 1971; and October [illegible], 197[illegible].

2. The New Hampshire Water Control Commission [illegible] on Dams in New Hampshire" (July 1[illegible], 19[illegible]).

3. The NHWRB "Inventory of Dams and Water [illegible] Developments" (October 3[illegible], 193[illegible]).

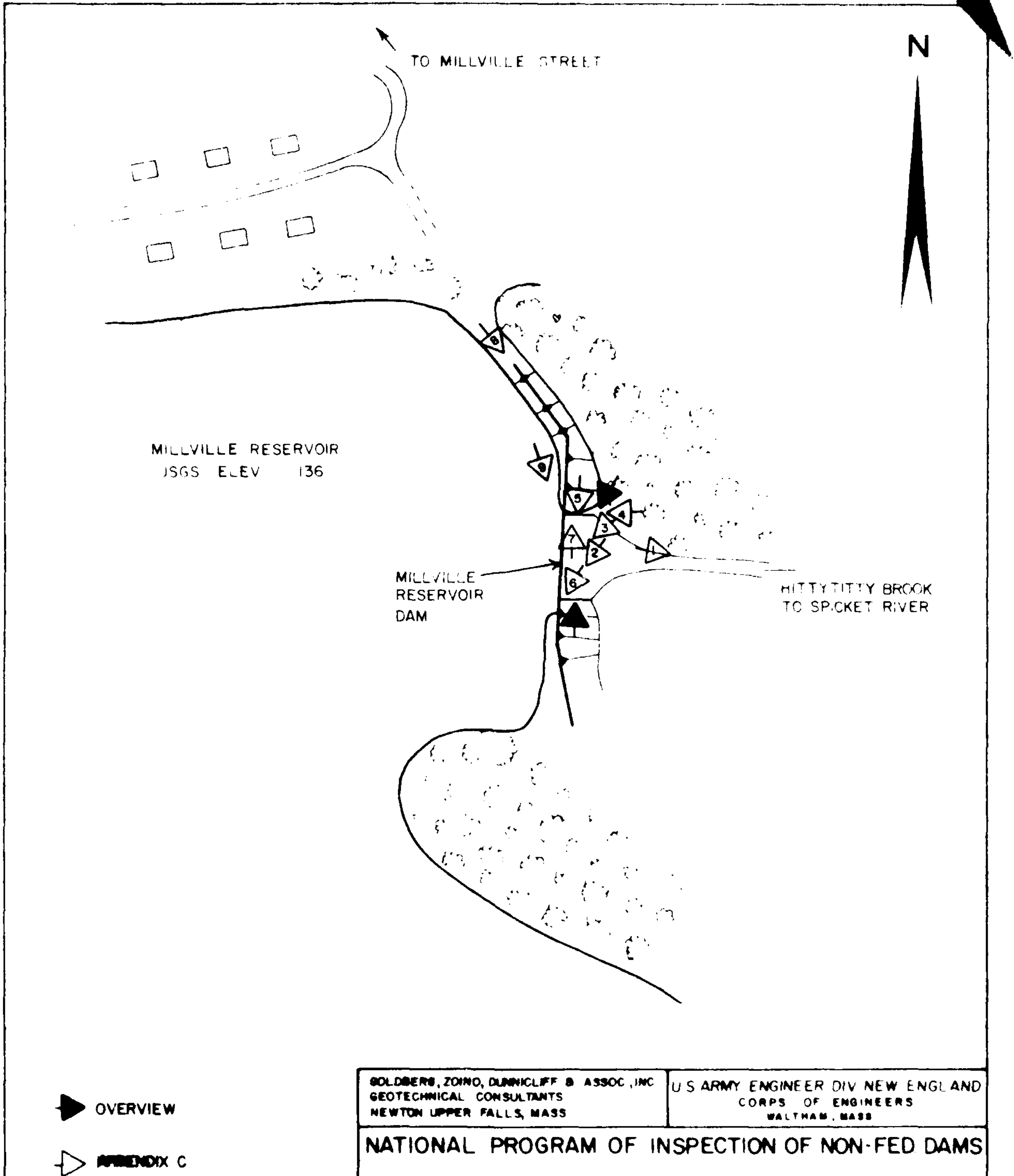
4. Public Service Commission's of New Hampshire [illegible] (November [illegible], 193[illegible]).

5. Construction sketches and specifications [illegible]

6. [illegible] of dam stability from a 19[illegible] [illegible]

[illegible]

[illegible]



GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS

U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

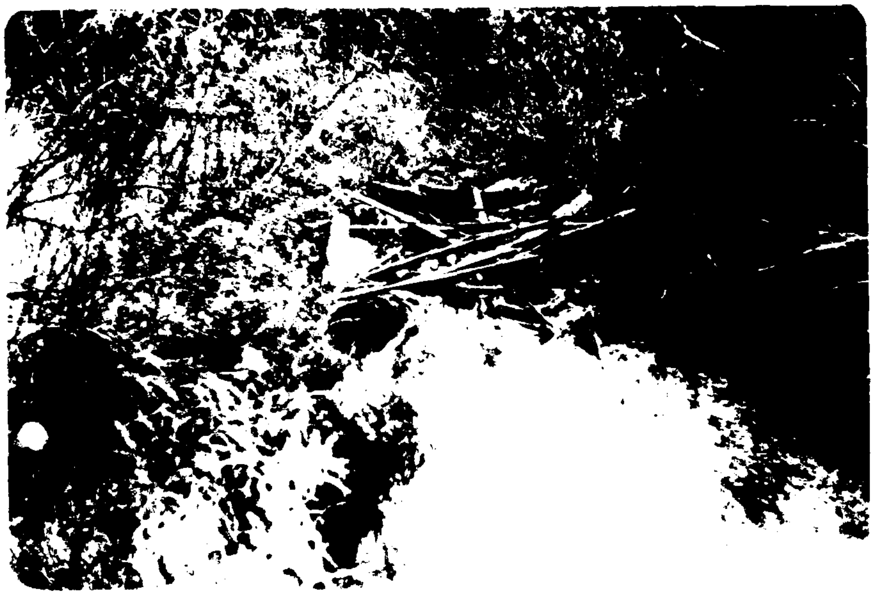
LOCATION AND ORIENTATION OF PHOTOS

MILLVILLE RESERVOIR DAM — NEW HAMPSHIRE

FILE No. 2201

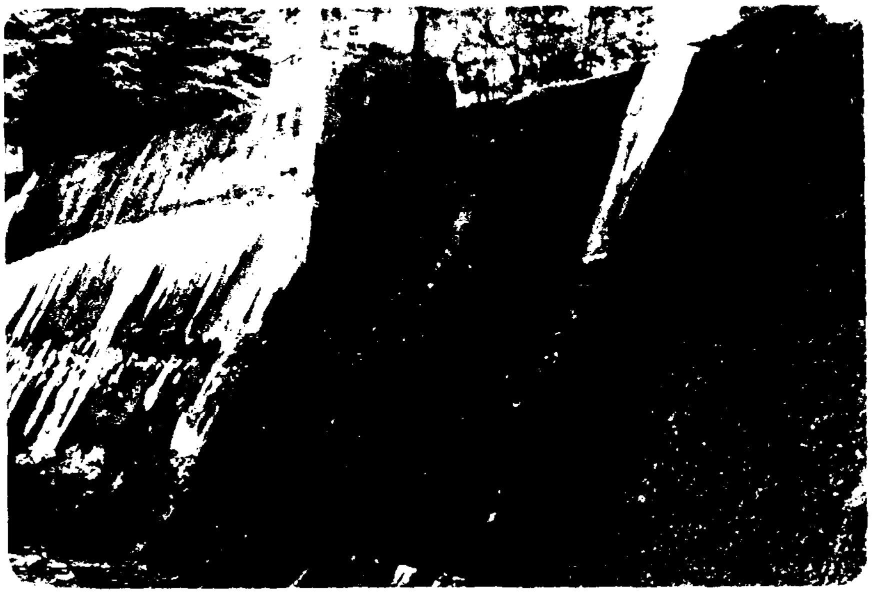
SCALE 1" ≈ 200'

DATE NOVEMBER 1978



1. View from dam of large quantity of debris in downstream channel

2. View from downstream channel of concrete deterioration on right side of spillway



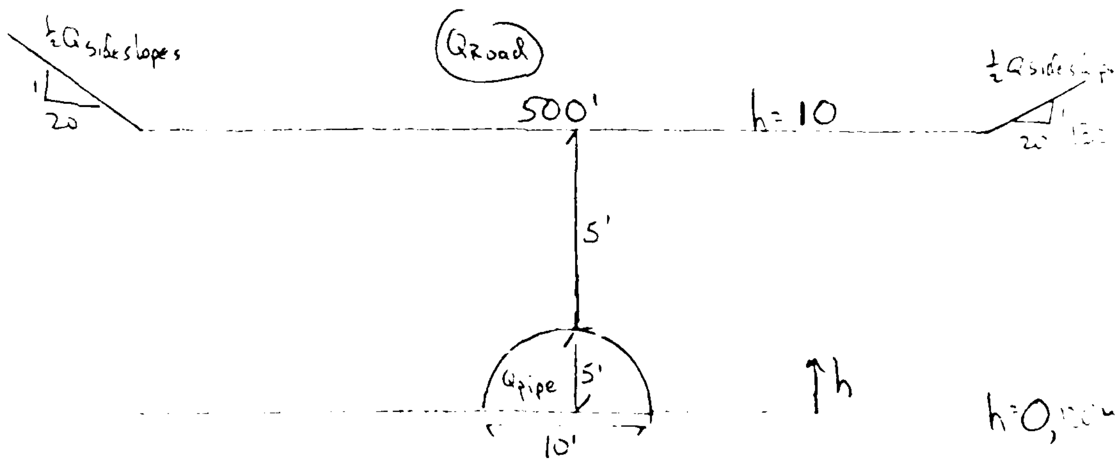
3. View from downstream channel of concrete deterioration on middle section of spillway

4. View from downstream channel of concrete deterioration on left side of spillway

Dam Failure Analysis

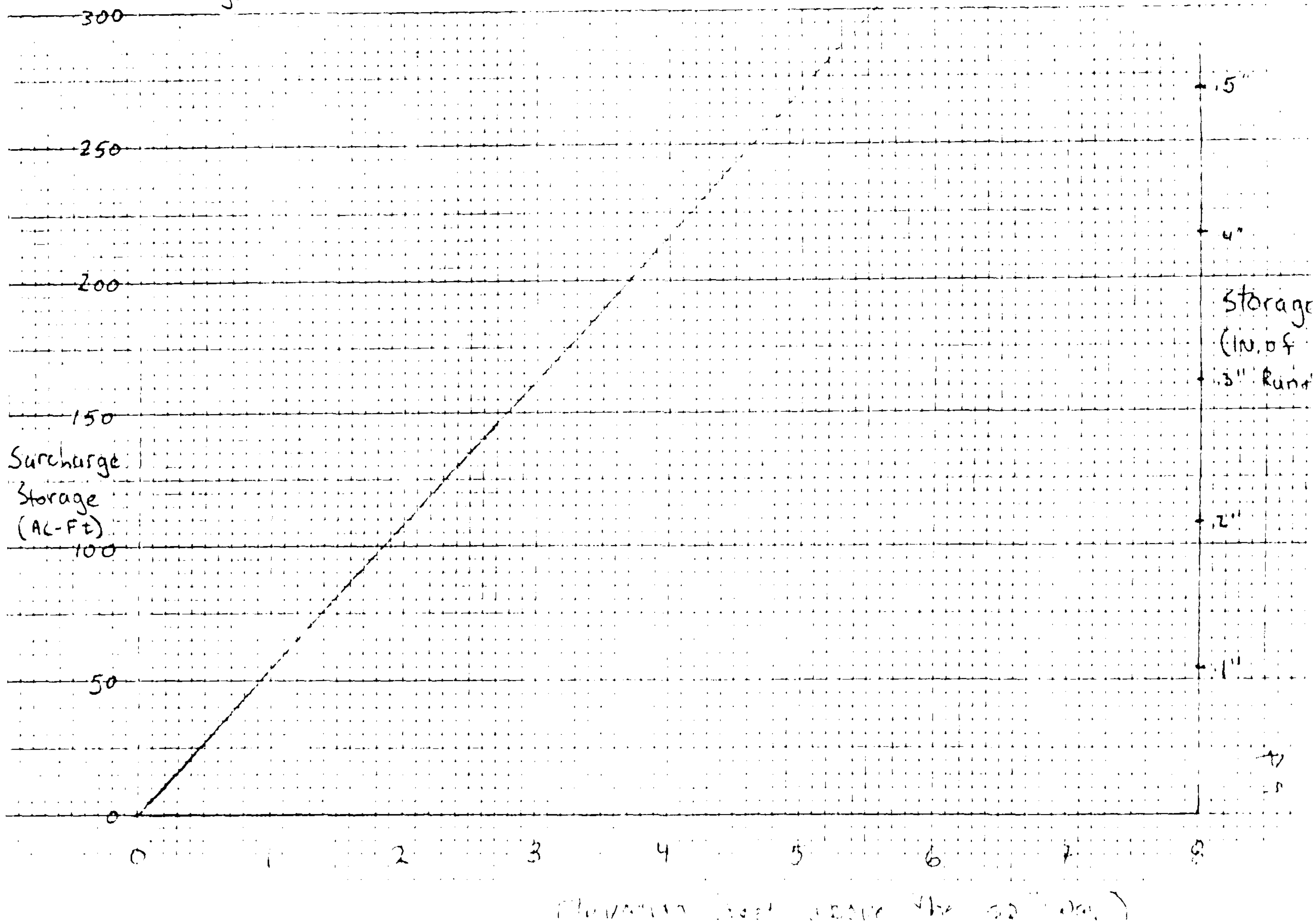
Assume that the dam fails when the water reaches the left abutment, h = 3.4' (elevation = 139.4' MSL). From the Stage-discharge curve, this would require a discharge of 1050 cfs.

It is necessary to determine the tailwater elevation from this flow. Tailwater at the dam at high flows is controlled by a culvert in Pine Grove Park development, some 2400' downstream of the dam. (see map, p. 11 ... culvert is ①) This culvert consists of a 10' diameter circular metal pipe. The pipe is half-full of dirt and debris. The top of the pipe is about 5' below the road surface. The roadway is at about U.S.G.S. elevation 130' MSL.



(not to scale)

Storage-Elevation Curve at Millville Reservoir Dam



Storage-Elevation Curve

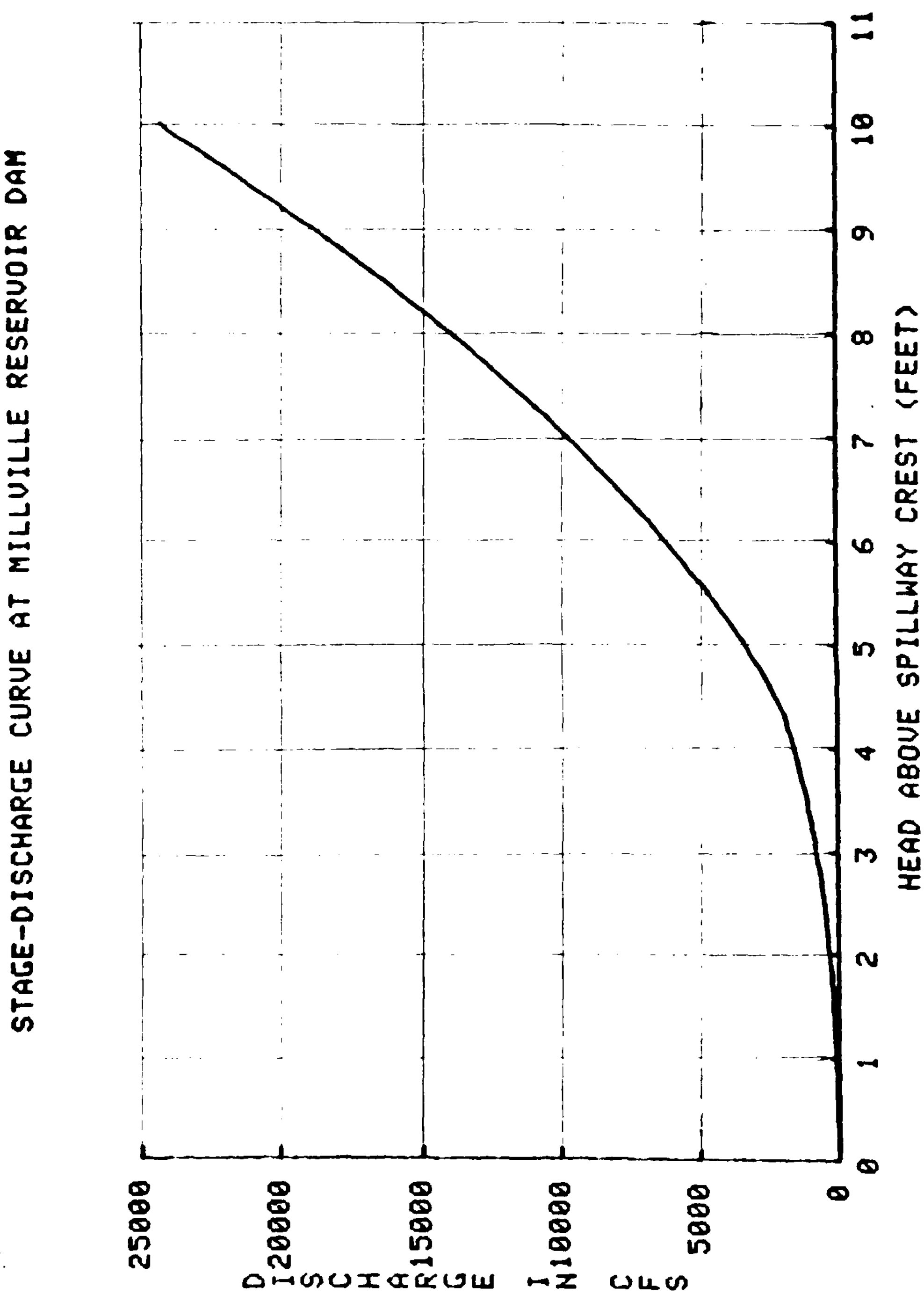
The storage-elevation curve for Millville Reservoir Dam is given on p. 9. This curve is based on a surface area of 54 acres and the assumption that the pond does not spread as it rises

1" of runoff over 10.1 sq. mi.

$$\rightarrow 1''(10.1)\left(640\ \frac{\text{acres}}{\text{sq mi}}\right)\left(\frac{1\text{ft}}{12\text{in}}\right) = 538.7\ \text{ac-ft.}$$

$$\rightarrow 1\text{ ft of rise} = \frac{1'\left(54\ \frac{\text{Ac-ft}}{\text{ft}}\right)}{538.7\left(\text{Ac-ft}/\text{in}\right)} = .1''\text{ of runoff}$$

P.7


STAGE-DISCHARGE CURVE AT MILLVILLE RESERVOIR DAM
HEAD ABOVE SPILLWAY CREST (FEET)
DISCHARGE IN CFS
0
1
2
3
4
5
6
7
8
9
10
11
0
5000
10000
15000
20000
25000

DISCHARGE FROM MILLVILLE RESERVOIR DAM AS A FUNCTION OF HEAD

HEAD (FEET)	DISCHARGE (CFS) TOTAL	LEFT BANK	RIGHT BANK	MIDDLE OF DAM	SPILLWAYS
0.00	0	0	0	0	0
0.25	11	0	0	0	11
0.50	32	0	0	0	32
0.75	58	0	0	0	58
1.00	90	0	0	0	90
1.25	126	0	0	0	126
1.50	165	0	0	0	165
1.75	228	0	0	0	228
2.00	310	0	0	0	310
2.25	406	0	0	0	406
2.50	513	0	0	0	513
2.75	635	0	0	0	635
3.00	776	0	0	0	776
3.25	933	0	0	0	933
3.50	1107	0	5	0	1102
3.75	1318	0	36	0	1282
4.00	1554	0	81	0	1473
4.25	1822	8	138	2	1674
4.50	2223	119	206	13	1884
4.75	2714	297	284	29	2104
5.00	3276	523	372	49	2332
5.25	3898	789	469	72	2568
5.50	4576	1091	575	98	2812
5.75	5305	1425	689	127	3064
6.00	6083	1789	812	158	3323
6.25	6907	2182	944	192	3589
6.50	7776	2601	1084	227	3863
6.75	8688	3047	1233	265	4143

p. 6

DISCHARGE FROM MILLVILLE RESERVOIR DAM AS A FUNCTION OF HEAD

HEAD (FEET)	DISCHARGE (CFS) TOTAL	LEFT BANK	RIGHT BANK	MIDDLE OF DAM	SPILLWAYS
0.0	0	0	0	0	0
0.5	32	0	0	0	32
1.0	90	0	0	0	90
1.5	165	0	0	0	165
2.0	310	0	0	0	310
2.5	513	0	0	0	513
3.0	776	0	0	0	776
3.5	1107	0	5	0	1102
4.0	1554	0	81	0	1473
4.5	2223	119	206	13	1884
5.0	3276	523	372	49	2332
5.5	4576	1091	575	98	2812
6.0	6083	1789	812	158	3323
6.5	7776	2601	1084	227	3863
7.0	9642	3517	1391	304	4430
7.5	11673	4530	1732	388	5023
8.0	13861	5634	2107	478	5642
8.5	16201	6826	2516	575	6284
9.0	18690	8103	2961	677	6949
9.5	21324	9462	3441	784	7637
10.0	24101	10901	3956	897	8346
10.5	27018	12419	4508	1015	9077
11.0	30075	14014	5096	1137	9827
11.5	33269	15685	5721	1264	10598
12.0	36599	17432	6384	1396	11387
12.5	40065	19253	7085	1531	12196
13.0	43666	21148	7824	1671	13023
13.5	47401	23116	8602	1815	13868

P.5

D.4

```
440 Q9=2.8*10*(H-4.2)*(0.5*(H-4.2))↑1.5
450 T1=Q1+Q2
460 T2=Q9+Q8
470 T3=T1+T2+Q3+Q4+Q5+Q6+Q7
480 T4=Q3+Q4+Q5
490 T5=Q6+Q7
500 PRINT USING 510:H,T3,T2,T1,T5,T4
510 IMAGE 1T,2D.2D,14D,11D.11D,13D,16D
520 NEXT H
530 END
```

P.3

```
list
100 REM: STAGE DISCHARGE PROGRAM FOR MILLVILLE RESERVOIR DAM, JOB 165
110 REM: ON TAPE 10, FILE 82
120 PAGE
130 PRINT "DISCHARGE FROM MILLVILLE RESERVOIR DAM AS A FUNCTION OF HEAD"
140 PRINT USING 150:
150 IMAGE // 2T"HEAD"30T"DISCHARGE"
160 PRINT USING 170:
170 IMAGE 1T"(FEET)"32T"(CFS)"
180 PRINT USING 190:
190 IMAGE 15T"TOTAL"7X"LEFT"7X"RIGHT"7X"MIDDLE"7X"SPILLWAYS"
200 PRINT USING 210:
210 IMAGE 27T"BANK"7X"BANK"8X"OF DAM"
220 FOR H=0 TO 6.75 STEP 0.25
230 Q1=0
240 Q2=0
250 Q3=0
260 Q4=0
270 Q6=0
280 Q7=0
290 Q8=0
300 Q9=0
310 Q5=3*30*H↑1.5
320 IF H<=1.5 THEN 450
330 Q4=3.3*47.6*(H-1.5)↑1.5
340 IF H<=2.6 THEN 450
350 Q3=3.3*24.2*(H-2.6)↑1.5
360 IF H<=3.4 THEN 450
370 Q2=2.8*60*(H-3.4)↑1.5
380 Q1=2.8*10*(H-3.4)*(0.5*(H-3.4))↑1.5
390 IF H<=4.1 THEN 450
400 Q6=3*8*(H-4.1)↑1.5
410 IF H<=4.2 THEN 450
420 Q7=3*13.2*(H-4.2)↑1.5
430 Q8=3*241*(H-4.2)↑1.5
```

for h = 2.6 to 3.4

$Q_3 = 3.3\ (24.2)\ (h - 2.6)^{3/2}$

all others unchanged

for h = 3.4 to 4.1

$Q_2 = 2.8(60)\ (h - 3.4)^{3/2}$

$Q_1 = 2.8\ (10)(h - 3.4)\ (.5(h - 3.4))^{3/2}$

all others unchanged

Broad-crested earth weir, C = 2.8

for h = 4.1 to 4.2

$Q_6 = 3.0(8)\ (h - 4.1)^{3/2}$

all others unchanged

for h = 4.2 and above

$Q_7 = 3.0(13.2)(h - 4.2)^{3/2}$

$Q_8 = 3.0\ (241)\ (h - 4.2)^{3/2}$

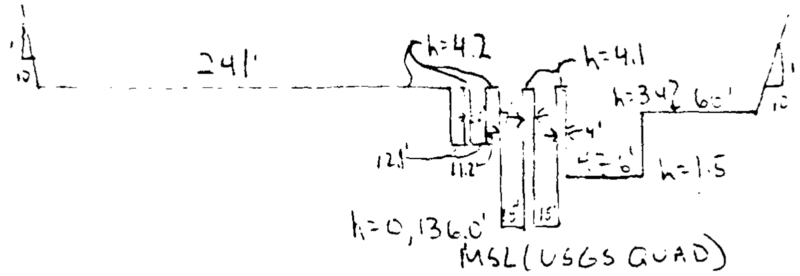
$Q_9 = 2.8\ (10)(h - 4.2)\ (.5(h - 4.2))^{3/2}$

all others unchanged.

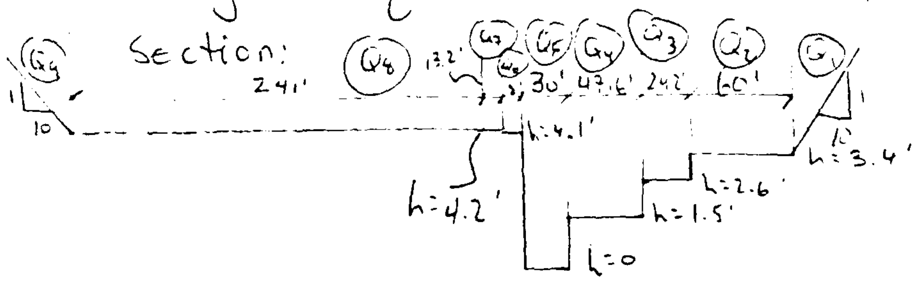
A BASIC program to calculate the stage-discharge relationship follows on pp. 3-7.

Stage-Discharge Curve

The information used to establish the cross section at Millville Reservoir Dam was determined from field notes and old plans:



The discharge is equivalent to that over this cross-section:



No operable gates

for h=0 to 1.5

$Q_5 = 3\,(30)\,h^{3/2}$

$Q_1 = Q_2 = Q_3 = Q_4 = Q_6 = Q_7 = Q_8 = Q_9 = 0$

Broad-crested concrete weir C = 3.0

for h = 1.5 to 2.6

$Q_4 = 3.3\,(47.6)\,(h-1.5)^{3/2}$

all others unchanged

At our flows of interest, this is a sharp-crested weir, C = 3.3

APPENDIX D

HYDROLOGIC/HYDRAULIC COMPUTATIONS

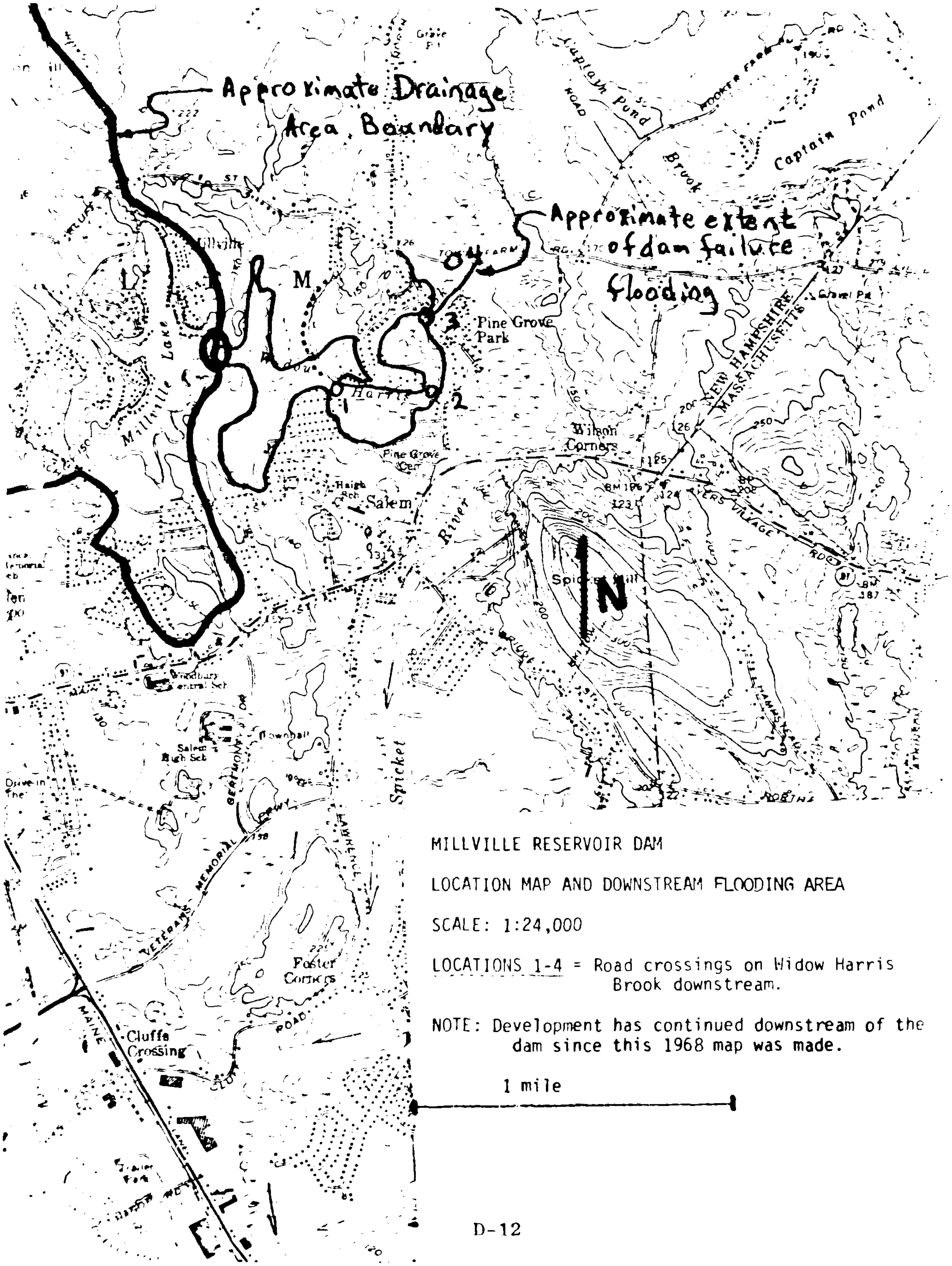
8. View of left embankment and concrete core wall

9. View of abandoned intake structure and upstream side of left spill-way end structure

7. View from downstream channel of deteriorated concrete and seepage through left endwall

5. View from left endwall of concrete deterioration on gate structure exposing reinforcement

6. View from downstream channel of deteriorated con rete and seepage through right endwall



MILLVILLE RESERVOIR DAM

LOCATION MAP AND DOWNSTREAM FLOODING AREA

SCALE: 1:24,000

LOCATIONS 1-4 = Road crossings on Widow Harris Brook downstream.

NOTE: Development has continued downstream of the dam since this 1968 map was made.

1 mile

Flows through the culvert were estimated using a nomograph is FHWA Hydraulic Engineering Circular No. 5, assuming inlet control.

Flow over the roadway was estimated using the weir equation for a broad crested weir with C = 3.0 :

$$Q_{road} = 3(500)(h-10)^{3/2}$$

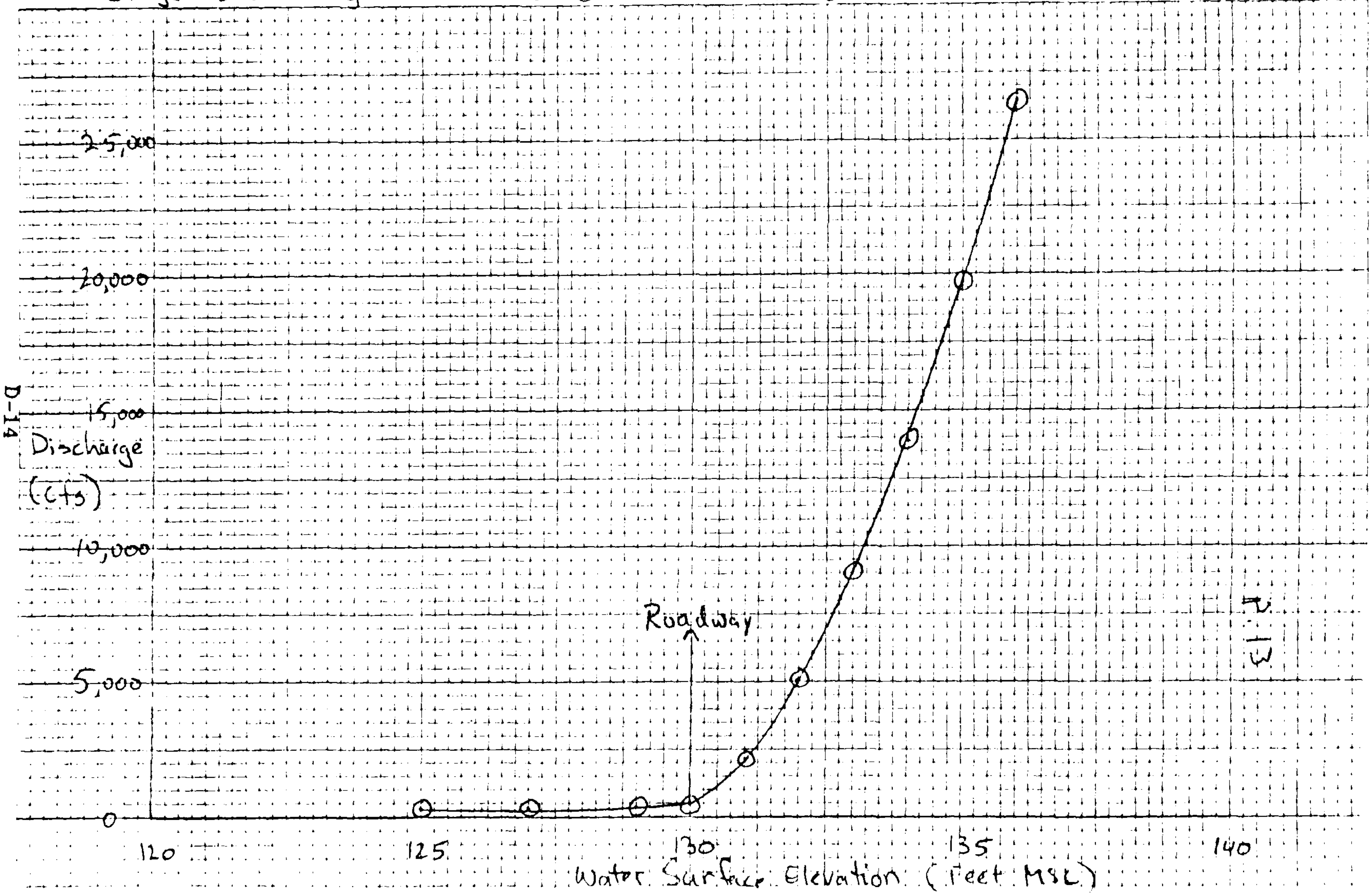
$$Q_{side\,slopes} = 3(20)(h-10)\,(.5(h-10))^{3/2} + 3(20)(h-10)(.5(h-10))^{3/2}$$

h (')	y ('MSL)	Q_{pipe} (cfs)	Q_{road} (cfs)	$Q_{sideslopes}$ (cfs)	Q_{TOTAL} (cfs)
5	125	270	0	0	270
7	127	370	0	0	370
9	129	430	0	0	430
10	130	470	0	0	470
11	131	490	1500	42	2030
12	132	525	4243	240	5010
13	133	560	7794	661	9020
14	134	585	12000	1358	13,940
15	135	615	16,771	2372	19,760
16	136	640	22,045	3741	26,430

The Stage-Discharge curve for this culvert is shown on p. 13.

D. 3… DIETZGEN GRAPH PAPER … DIETZGEN CORPORATION

Stage-Discharge Curve at Culvert 2400' Downstream of Millville Reservoir Dam



Thus, at the pre-failure flow of 1050 cfs, the tailwater elevation at the dam would be about 130.5' MSL, .5' above the roadway.

Peak Failure outflow = normal outflow + breach outflow

Normal outflow:

$Q = 1050$ cfs for $h = 3.4'$ above spillway crest

Breach outflow:

$$Q_{P_1} = 8/27\ W_b \sqrt{g}\ y_o^{3/2}$$

W_b: Width of breach, $\leq .4$ (total width).

Assume $W_b = .4$ (length of earth embankment overtopped)

$= .4(241) = 96$ ft.

y_o = height above tailwater = $(136+3.4) - 130.5 = 8.9'$

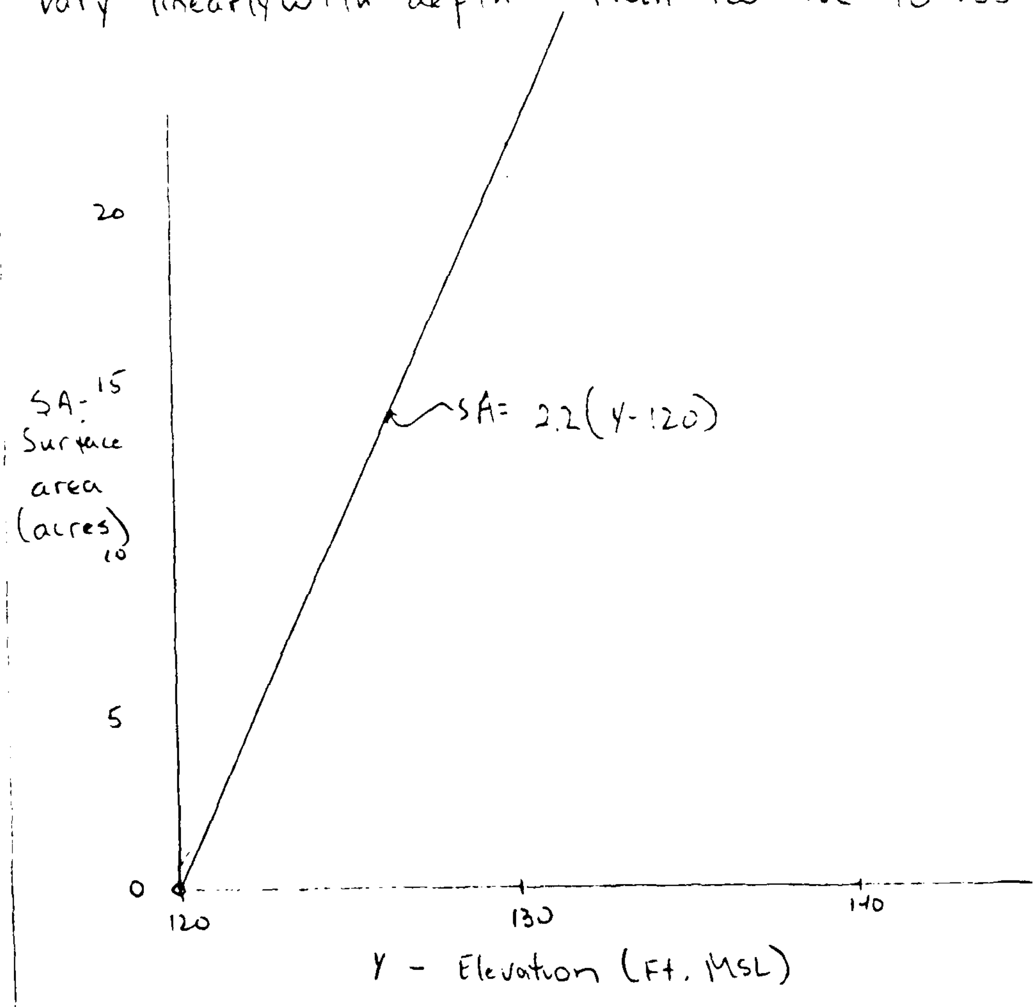
$$Q_{P_1} = 8/27\ (96)\ \sqrt{32.2}\ (8.9)^{3/2} = 4290 \text{ cfs}$$

Peak outflow = 1050 + 4290 = 5340 cfs

We will use the COE's suggested graphical routing method to determine the flow reduction in the first reach, and thus the stage resulting from the failure outflow. To do this, we require the Storage-Elevation relationship for the reach of the Widow Harris River between the dam and the culvert.

This was estimated as follows:

The surface area at water surface elevation =120' MSL was estimated as 0. The surface area at water surface elevation 130' MSL was estimated by planimeter as 22 acres. The surface area was assumed to vary linearly with depth from 120' MSL to 135' MSL:



The equation for this linear relationship is:

$$S.A. = 2.2(Y - 120)$$

Volume of storage can be determined:

$$V = \int 2.2\,(y-120)\,dy$$

$$= 1.1\,y^2 - 264\,y + C$$

at $y = 120$, $V = 0$, so

$$C = 264(120) - 1.1(120)^2 = 15{,}840 \text{ ac-ft}$$

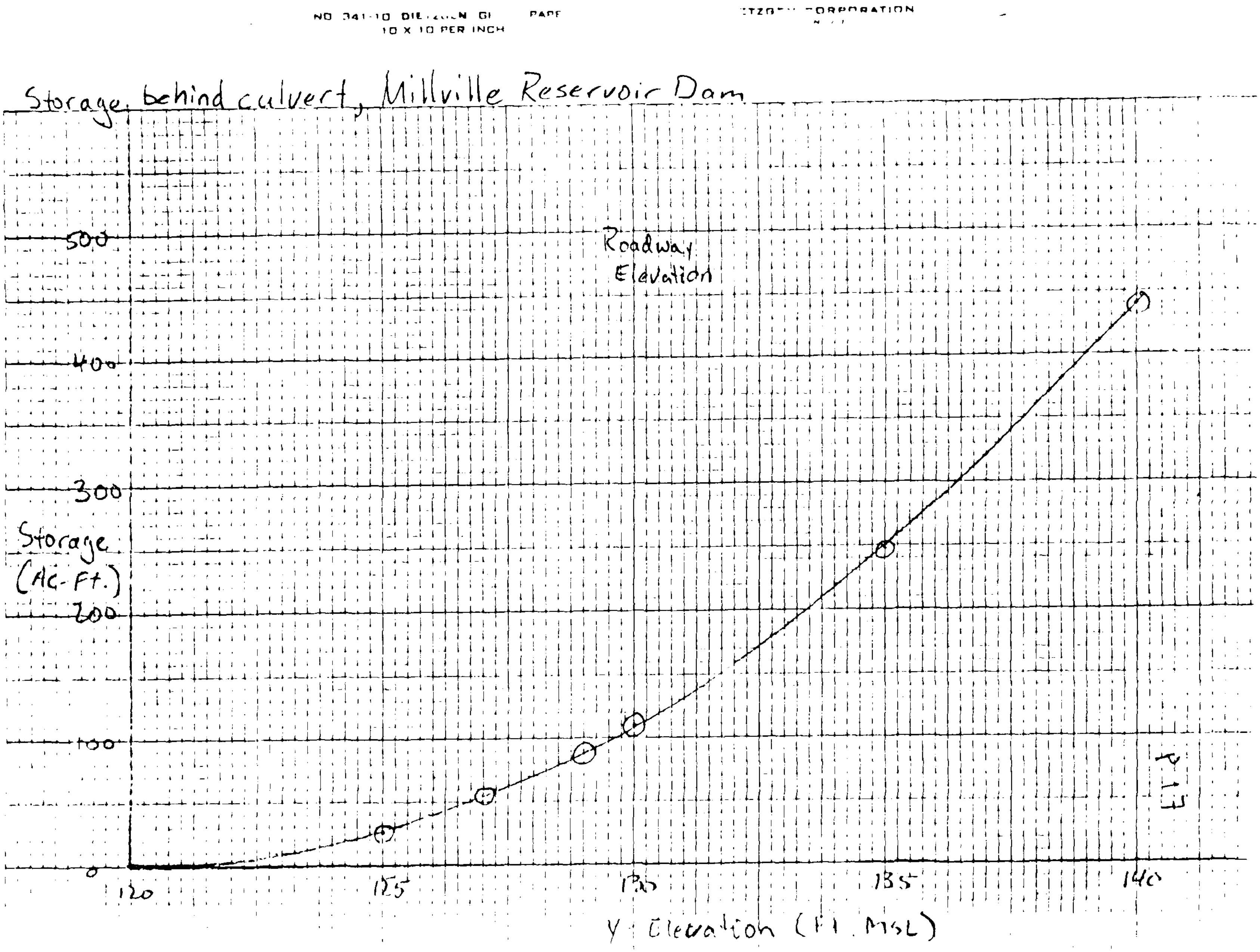
$$V = 1.1\,y^2 - 264\,y + 15{,}840$$

y	V (ac ft.)
120	0
121	1.1
122	4.4
123	9.9
124	17.6
125	27.5
126	39.6
127	53.9
128	70.4
129	89.1
130	110

y	V (ac-ft)
135	247.5
140	440

The Storage-Elevation Curve for this reach is on p. 17.

Storage behind culvert, Millville Reservoir Dam



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10 PER
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Dam Break Routing through Culvert

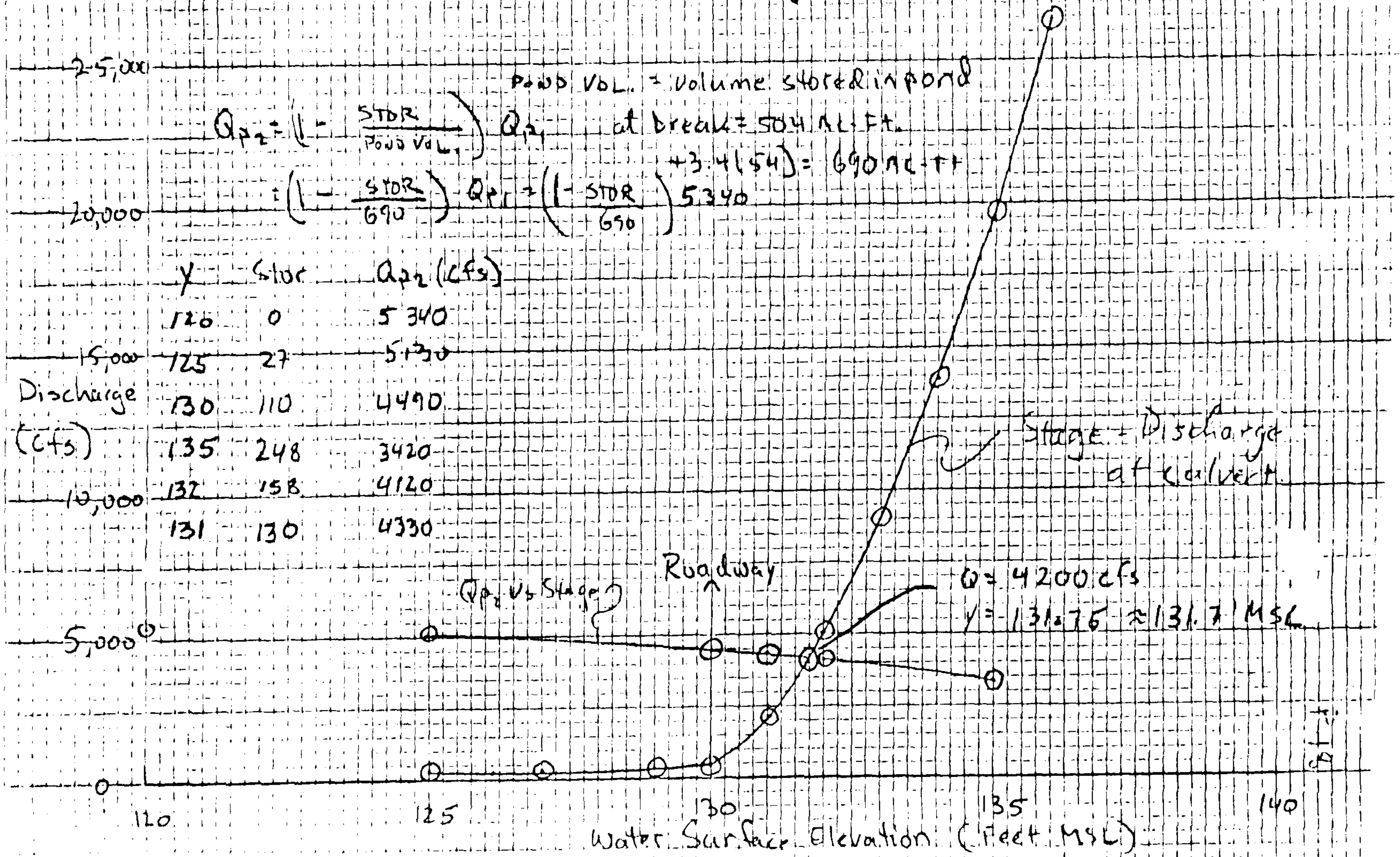
POND VOL. = Volume stored in pond at break = 504 AC-FT.

+3.4(54) = 690 AC-FT

$$Q_{p_2} = \left(1 - \frac{STOR}{POND\ VOL_1}\right) Q_{p_1}$$

$$= \left(1 - \frac{STOR}{690}\right) Q_{p_1} = \left(1 - \frac{STOR}{690}\right) 5340$$

Y	Stor	Q_{p_2} (cfs)
120	0	5340
125	27	5130
130	110	4490
135	248	3420
132	158	4120
131	130	4330



Thus dam failure raises the water level in the first reach by 1.2' to 1.7' above the road. There is extensive development in this area, which is part of the Pine Grove Park subdivision of Salem, New Hampshire. The water level prior to dam failure would cause some flooding, which would be increased significantly by dam failure.

The dam failure outflow would continue to cause such increases in flow and water surface elevation as the failure wave proceeded downstream on the Widow Harris River. The flow would continue to be attenuated by the swampy areas and culverts downstream, but a large increase in flooding would result from dam failure.

165 Dam Safety Millville Reservoir Dam TCG, 3/15/7_

Test Flood Analysis

Size classification: Small

Hazard Classification: Significant

The hazard classification is significant because of the probability of increased downstream flooding in residential areas due to dam failure. The fact that water levels would rise only 1-2 feet, and thus would not present a large threat of loss of life, makes significant appropriate rather than high.

Test Flood: 100 year to 1/2 PMF.

Because the hazard is on the high side of significant, we will use the 1/2 PMF.

The area draining to Millville Reservoir is hilly, with interspersed areas of marsh and several small reservoirs. Thus, using the Corps PMF peak flow rates chart, we selected a flow of 1000 csm for the PMF → 1000/2 = 500 csm for the 1/2 PMF.

Peak inflow = 500 csm (10.1 sq. mi.) = 5050 cfs.

$= \frac{19}{2} = 9.5''$ runoff.

$$Q_{P_2} = Q_{P_1}\left(1 - \frac{STOR}{9.5}\right) = 5050\left(1 - \frac{STOR}{9.5}\right)$$

STOR in " of runoff.

h ('above spillway)	Y (Ft. MSL)	STOR (" of runoff)	Q_{P2}
0	136	0	5050
2	138	.2	4940
4	140	.4	4840
6	142	.6	4730
8	144	.8	4620
10	146	1.0	4520

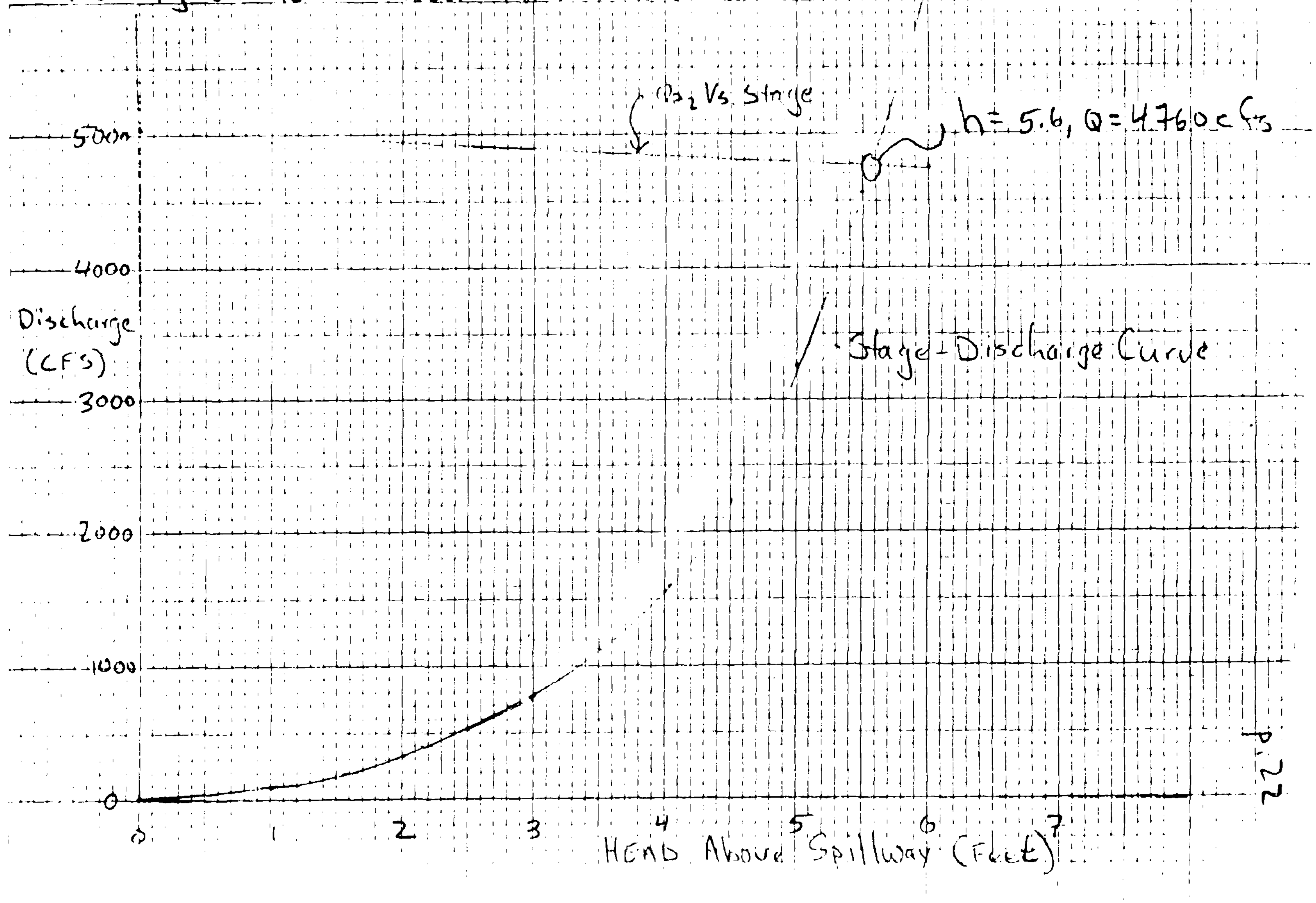
The graphical routing to determine attenuation by storage is shown on p.22

The attenuated outflow is 4760 cfs, with the peak water level 5.6 feet above the spillway crest. (2.2 feet above the left abutment, 1.4 feet above the right abutment, elevation 141.6 MSL).

The location of Millville Reservoir Dam is shown on p. 11.

NO 10 X 10 DIETZGEN GRAPH PAPER 10 X 10 PER INCH DIETZGEN CORPORATION MADE IN U.S.A.

Routing of Test Flood - Millville Reservoir Dam



APPENDIX E

INFORMATION AS CONTAINED IN
THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

NAME

MILLVILLE RESERVOIR DAM

LATITUDE NORTH | LONGITUDE WEST | REPORT DATE DAY MO YR

27APR79

POPULAR NAME

NAME OF IMPOUNDMENT

MILLVILLE LAKE

REGION BASIN | RIVER OR STREAM | NEAREST DOWNSTREAM CITY - TOWN - VILLAGE | DIST FROM DAM MI | POPULATION

SALEM | 1 | 1000

TYPE OF DAM | YEAR COMPLETED | PURPOSES | STRUC HEIGHT | HYDRAU HEIGHT | IMPOUNDING CAPACITIES MAXIMUM NORMAL

1917 | 52 | 19 | 690 | 504

27APR79

REMARKS

CONCRETE AND EARTH 23=AESTHETIC

SPILLWAY | MAXIMUM DISCHARGE | VOLUME OF DAM | POWER CAPACITY INSTALLED MW | NAVIGATION LOCKS

1050

OWNER | ENGINEERING BY | CONSTRUCTION BY

DESIGN | CONSTRUCTION | REGULATORY AGENCY OPERATION | MAINTENANCE

NH WATER RES BD | NH WATER RES BD | NH WATER RES BD | NH WATER RES BD

INSPECTION BY | INSPECTION DATE DAY MO YR | AUTHORITY FOR INSPECTION

PUBLIC LAW 92-367

REMARKS

END